fuel sulfur levels higher than the proposed level were adopted. We also recognize that technology evolution may affect the sulfur level at which these technologies are enabled.

Therefore, we are evaluating whether or not the proposed program could benefit from a future reassessment of the control effectiveness of diesel NO_X exhaust emission control technologies and associated fuel sulfur requirements. We would expect to conduct such a reassessment in the 2003 timeframe, though we welcome comment on whether such a reassessment will be needed and on the appropriate timing for it. We also welcome comment on the extent to which a review of NO_X control technology should also include a review of the appropriate diesel fuel sulfur level for enabling the NO_X control technology, including consideration of impacts that a revised fuel requirement would have on PM control technology. Another possible area for consideration during the reassessment could be non-conformance penalties (NCPs) and the role they might play in this program. NCPs would allow engine manufacturers to produce and sell noncomplying engines under limited circumstances in exchange for paying a penalty to the government. We welcome comment on the role NCPs may play.

In conducting the review, we would expect to determine whether or not there was a need to formally consider a change in the final regulations adopted for this program. If such a change were determined to be necessary, we would conduct a formal rulemaking, including conducting public hearings.

I. Encouraging Innovative Technologies

We encourage comments on approaches that could provide increased incentives for the development and introduction of clean advanced engine technologies. Some such approaches have been suggested by stakeholders or have been a part of other EPA rules. One of these would be to develop a program for providing a special designation for engines or vehicles that are significantly below the standards or use specific innovative propulsion technologies. EPA finalized such a designation, the ''Blue Sky Series Engine'' program, as a part of the 1998 nonroad diesel standards final rule. Incorporating such a designation could be very valuable for use in programs developed by states, municipalities, or corporations to highlight or reward the purchase and use of especially clean or innovative vehicles and engines. We request comment on how we might structure a program like the ''Blue Sky Series'' program in the context of today's proposal, including what criteria we should use to qualify an engine or vehicles for such a designation.

It has also been suggested that we might adapt the proposed ABT program described in section VII.C. below to provide extra incentives for manufacturers that encourage innovative technologies. For example, manufacturers might get additional credits under the ABT program if they introduce extra clean models or if they meet future standards early. We believe our current ABT program, with the proposed revisions discussed below, should encourage manufacturers to seriously consider any technologies that can economically reach the very low emission levels proposed today. Nevertheless, we request comment on the need for and appropriateness of such additional provisions under the ABT program.

IV. Diesel Fuel Requirements

As discussed in section III above, we believe that advanced exhaust emission control technology exists and is being developed that can reduce emissions of NO_X and PM to very low levels. However, those exhaust emission control technologies will require changes to diesel fuel in order to operate efficiently and reach the new engine emissions standards we are proposing in today's NPRM. This section will present our proposed changes to diesel fuel that are intended to enable heavy-duty engines to meet our proposed new emission standards. We will also describe the extent and applicability of the proposed diesel fuel program, the means through which we expect refiners to meet the new diesel fuel standards, and incentives we are providing refiners for early introduction. The economic and environmental impacts of the proposed diesel fuel program will be covered in subsequent sections in combination with the implications of the proposed engine standards.

A. Why Do We Believe New Diesel Fuel Sulfur Controls Are Necessary?

In section III, we discussed our proposed finding that new standards for heavy-duty engines can be established on the basis of exhaust emission controls which we believe will be fully viable and widely available for the 2007 model year. However, we also discussed our understanding that those exhaust emission control technologies have a significant and irreversible sensitivity to the sulfur content of the fuel. Deep sulfur reductions are necessary to enable both the NO_X and PM emission control technology that we believe vehicles would need to use to achieve the emission standards we are proposing today. Since we believe that new standards for heavy-duty engines are an appropriate next step for reducing ambient pollution, and it is these very exhaust emission control technologies which manufacturers are likely to use in order to reach these low emission levels, we are proposing to reduce the sulfur content of highway diesel fuel.

Engine manufacturers and representatives of States, and environmental and public health organizations have expressed general support for a highway diesel fuel sulfur reduction strategy similar to the gasoline sulfur reduction program. However, some stakeholders, in particular refiners, have expressed concern that the sulfur sensitivity of heavy-duty diesel exhaust emission controls has not been quantified with a sufficient degree of certainty to provide a basis for setting a specific low sulfur standard. Although it is likely that the efficiency of exhaust emission control technology improves with decreasing fuel sulfur levels all the way down to nominally zero levels, we believe that it is possible to set a non-zero sulfur standard that sufficiently enables high-efficiency control technology. The sulfur standard we are proposing and the associated justification is described in more detail in section IV.B below.

Sulfur appears to be the only diesel fuel property that must be changed in order for the prospective exhaust emission control technologies to operate effectively. Changes in other fuel properties, such as cetane, aromatics, density, and high-end distillation, might all provide small emission benefits for engines meeting our proposed standards, but those benefits would be very small in comparison to the sulfur standard. They would also not enable new advances in emission control technology, and so would not likely produce significant step changes in heavy-duty engine emissions. See section VI.B for a more complete discussion of non-sulfur property changes for diesel fuel.

Finally, there is also an expectation on the part of some automobile manufacturers that diesel engines will be used more frequently in light-duty vehicles in the coming decade. However, any light-duty diesel vehicles will be required to meet our final Tier 2 standards, which we believe will require the use of the same high efficiency exhaust emission control technologies envisioned for heavy-duty applications. Although we are not proposing a change to diesel fuel specifically for light-duty diesel vehicles, it is our expectation that the availability of a low-sulfur fuel intended primarily to enable heavy-duty engines to meet our proposed new standards would enable automobile manufacturers to produce light-duty diesel vehicles that could meet the Tier 2 standards. We would like comment on whether any other changes to diesel fuel specifically for light-duty diesel vehicles are necessary, and on the appropriateness, benefits, and costs of doing so.

B. What New Sulfur Standard Are We Proposing for Diesel Fuel?

We are proposing to require substantial reductions in diesel fuel sulfur levels nationwide. Our proposal would require that all highway diesel fuel produced or imported by refiners and importers be subject to a maximum sulfur level of 15 ppm by weight. The technological need for low-sulfur diesel fuel and the reasons for our proposed sulfur standard are discussed in section III above. However, we are also seeking comment on whether the sulfur standard should be set as high as 50 ppm or as low as 5 ppm, as well as what the associated costs and benefits would be of a higher or lower level. (See section VI.B. for further discussion of various sulfur standards.)

We believe our proposed diesel fuel sulfur program balances the goal of achieving dramatic reductions in emissions from heavy-duty vehicles with the goal of providing sufficient lead-time for the engine emission control technology to develop and for the refining industry to transition to a lower sulfur diesel fuel. Nevertheless, as noted elsewhere, we are seeking comments on all these issues. We are aware of diesel fuel industry concerns about their ability to consistently deliver fuel meeting this low cap requirement. We are also aware that some engine manufacturers are concerned that even fuel meeting the 15 ppm cap requirement may not adequately enable the exhaust emission control technologies. In determining the appropriate sulfur level and scope for our proposed program, we considered the implications of diesel fuel sulfur on the emission control hardware of both heavy-duty and light-duty vehicles (that is, light-duty diesel vehicles that are required to meet our Tier 2 emission standards). Specifically, we analyzed the degree to which the emission control devices described in section III, above, may tolerate diesel fuel sulfur. We also evaluated the environmental implications of sulfur control beyond the expected NO_X and PM benefits (see section II) and the costs of controlling fuel sulfur content, and we considered the ability of all refiners and importers to meet the proposed diesel fuel sulfur standard at essentially the same time (see section IV.D). We hope to benefit from further discussion of all of these issues during the public comment period.

The following sections describe in more detail the standard we are proposing and the reasons why we are proposing a program that applies year-round and nationwide.

1. Why Is EPA Proposing a 15 ppm Cap and Not a Higher or Lower Level?

There are five key factors which, when taken together, lead us to propose that a diesel fuel sulfur cap of 15 ppm is both necessary to enable the NO_X and PM exhaust emission control technology (and thereby allow the proposed emission standards to be met), and appropriate, taking into consideration the challenges involved in providing low-sulfur fuel. These factors, as discussed in more detail in sections III and IV.D, are the implications that sulfur levels in excess of 15 ppm would have for the efficiency, reliability, and fuel economy impacts of the exhaust emission control systems, and the feasibility and costs of producing low-sulfur diesel fuel.

The efficiency of emission control technologies at reducing harmful pollutants is directly impacted by sulfur in diesel fuel. Initial and long term conversion efficiencies for NO_X, NMHC, CO and diesel PM emissions are significantly reduced by catalyst poisoning and catalyst inhibition due to sulfur. NO_X conversion efficiencies with the NO_X adsorber technology in particular are dramatically reduced in a very short time due to sulfur poisoning of the NO_X storage bed. In addition total PM control efficiency is negatively impacted by the formation of sulfate PM. The formation of sulfate PM is likely to be in excess of the total PM standard proposed today, unless diesel fuel sulfur levels are below 15 ppm.

The reliability of the emission control technologies to continue to function as required under all operating conditions for the life of the vehicle is also directly impacted by sulfur in diesel fuel. As discussed in section III, sulfur in diesel fuel can prevent proper operation and regeneration of both NO_X and PM control technologies leading to permanent loss in emission control effectiveness and even catastrophic failure of the systems. We believe that diesel fuel with sulfur levels less than 15 ppm will be required to provide a level of reliability for these technologies to allow their introduction into the marketplace.

The sulfur content of diesel fuel will also affect the fuel economy of vehicles equipped with NO_X and PM exhaust emission control technologies. As discussed in detail in section III, NO_X adsorbers are expected to consume diesel fuel in order to cleanse themselves of stored sulfates and maintain efficiency. The larger the amount of sulfur in diesel fuel, the greater this impact on fuel economy. As sulfur levels increase above 15 ppm the fuel economy impact transitions from merely noticeable to levels most diesel vehicle operators would consider unacceptable (see discussion in section III). Likewise PM trap regeneration is inhibited by sulfur in diesel fuel. This leads to increased PM loading in the diesel particulate filter, increased exhaust backpressure, and poorer fuel economy. Thus for both NO_X and PM technologies the lower the fuel sulfur level the better the fuel economy of the vehicle.

As a result of these factors, we believe that 15 ppm represents an upper threshold of diesel fuel sulfur levels that would make these technologies viable, and are therefore proposing to cap in-use sulfur levels there. In comments received on the ANPRM, as well as in subsequent meetings and discussions, however, we have often heard different points of view on this issue expressed by the vehicle and engine manufacturers, and by oil refiners.

Some vehicle and engine manufacturers have argued for a maximum cap on the sulfur content of diesel fuel of 5 ppm, believing that this level is necessary. As we discuss in section III, however, we believe that a cap of 15 ppm (likely resulting in an in-use sulfur level 7 to 10 ppm) would be sufficient to ensure the reliability of PM exhaust emission control technology (avoid potential for irreversible failure) and enable it to reach the very high efficiencies needed over the wide range of vehicle operation and conditions that would be needed for the engines to comply with our proposed standards. Although at the current stage of development, high efficiency NO_X technology is extremely sulfur intolerant, work is already underway to develop capability in the technology to tolerate at least some sulfur in the fuel. As discussed in section III, however, it is likely that to maintain the very high operational efficiencies of the emission control equipment that we believe would be needed to meet the proposed emission standards, and to avoid a significant fuel economy penalty, the sulfur level in the fuel would still have to be very low.

We believe that requiring a cap lower than 15 ppm would not be necessary to enable the exhaust emission control technology to meet the very low NO_X and PM emission standards proposed. A cap lower than 15 ppm would provide little additional emission reduction but would increase the cost. Consequently, requiring a sulfur cap lower than that necessary to enable the exhaust emission control technology to meet the emission standards would be inappropriate. Further discussion and analysis of alternative sulfur standards is contained in section VI.

Conversely, many oil refiners have argued for a higher maximum cap (if any) on the content of sulfur in diesel fuel, typically on the order of 50 ppm. They argue that the cost of reducing the sulfur level below a cap of 50 ppm (and average of 30 ppm) becomes prohibitively high. They further argue that diesel engine exhaust emission control technology is still in its infancy and will likely develop rapidly over the next several years to the point where it is much less sulfur sensitive than the technology of today. As discussed in section III, we also believe that the diesel engine exhaust emission control technology will develop rapidly over the coming years, and in particular are projecting that the sensitivity of NO_X adsorber technology to fuel sulfur will improve considerably through the development of techniques to effectively regenerate themselves of stored sulfur compounds. The Manufacturers of Emission Controls Association (MECA) recently sent a letter strongly supporting this position, stating "we strongly believe that NO_X adsorber technology will be commercially available in 2007 to help heavy-duty diesel engines meet the stringent NO_X standards being considered by EPA and that any current engineering challenges involved with this technology will be addressed provided that very low sulfur fuel is available." [127] Based on available information and our projections from that information, we believe that a cap higher than 15 ppm sulfur, and in particular a cap as high as 50 ppm would not enable the exhaust emission control technology needed to achieve the proposed emission standards and furthermore may severely compromise the reliability of the systems and result in unacceptable fuel economy impacts. In addition, as discussed in section IV.D below, although we acknowledge that the cost to desulfurize diesel fuel does increase with more stringent sulfur levels, we believe that these costs would not be prohibitively high, and maintain that the environmental benefits of the program are sufficient to justify the costs of the program at a sulfur cap level of 15 ppm.

Based on our assessment of the efficiency, reliability, and fuel economy impacts of sulfur on diesel engine exhaust emission control technology, and the cost and feasibility factors associated with reducing the sulfur content of diesel fuel, we propose to adopt 15 ppm as the appropriate sulfur cap. However, we have analyzed the impacts on technology enablement, costs, and benefits from controlling fuel sulfur to a 15 ppm average level with a 25 ppm cap, as well as from capping fuel sulfur at 5 ppm and 50 ppm. These levels have been put forward by various stakeholders as either necessary (in the case of a 5 ppm cap) or adequate (in the case of a 50 ppm cap) for enabling high-efficiency diesel exhaust emission controls, and so we believe that assessments of these levels is appropriate. These assessments are discussed in section VI.B. We request comment on the appropriate level of the highway diesel fuel sulfur standard, and on our assessment of alternative standards.

2. Why Propose a Cap and Not an Average?

We are proposing a cap on the sulfur content of diesel fuel in order to protect the vehicle aftertreatment technologies that we expect would be used to meet the proposed standards for heavy-duty engines and vehicles. An average standard by itself would not be sufficient to ensure that sulfur levels higher than those that could be tolerated by the exhaust emission control technology would not be used in vehicles for extended periods of time. Consequently, we do not believe that an average standard can stand by itself and would at minimum have to be coupled with a cap.

3. Should the Proposed 15 ppm Cap Standard Also Have an Average Standard?

Although our current 500 ppm sulfur limit for diesel fuel provides no averaging flexibility, in the years since that limit was set our motor vehicle fuel regulations have frequently incorporated provisions allowing regulated industries to average regulated parameters around a standard, often with a capped upper limit. In fact this approach was taken in the recently promulgated control of gasoline sulfur levels, in which we adopted a 30 ppm average level with an 80 ppm cap.

Despite the ability of averaging provisions in some programs to increase compliance flexibility and in some cases reduce overall costs while still achieving the environmental objectives, we are not proposing such provisions for the diesel fuel sulfur standard we are proposing today. Basing the fuel program around an average sulfur level could risk failure in meeting the whole objective of sulfur control (the enablement of sulfur-sensitive technologies) and thereby the environmental objectives of the program, or else could require the adoption of a cap so low as to make the average level largely irrelevant. The exhaust emission control technologies enabled by diesel sulfur control appear to be far more sensitive to and far less forgiving of variations in fuel sulfur level than advanced Tier 2 gasoline technologies. Enough is known about the exhaust emission control technologies to convince us that the proposed sulfur level will likely represent an enablement threshold level, above which increases in emissions and potentially system failures could be expected. Consumption of diesel fuel with sulfur levels above this threshold could be very problematic.

Some commenters who responded to our diesel fuel ANPRM did express interest in an averaged fuel sulfur standard, but only from the viewpoint that the flexibility provided by averaging is generally desirable, and not with specific solutions to the above-discussed problems created by this approach. Other commenters opposed an averaging requirement due to the test burden associated with demonstrating compliance under such a program. We request specific suggestions on how to structure a viable averaging requirement in conjunction with a 15 ppm cap, and whether it would be desirable to do so. One benefit of having only a cap instead of an average is that it allows for a simplified enforcement scheme. Imposing an average standard in addition to the cap would require additional product sampling, recordkeeping, and reporting requirements to demonstrate compliance with the standard. Thus, depending on how the program is structured, the flexibility of an average standard may not be worth the additional cost and complexity that would result, particularly with a cap set at 15 ppm.

Some have suggested that it may be possible to set an average standard of 10 ppm coupled with a higher cap. They

[127] Letter to Carol Browner, Administrator of EPA from Bruce Bertelsen, Executive Director of Manufacturers of Emission Controls Association, May 3, 2000.

suggest that a 10 ppm average would achieve essentially the same average in-use sulfur level as the proposed 15 ppm cap, and that as long as the cap is sufficiently protective of the exhaust aftertreatment technology, then the refining and distribution systems may have greater flexibility in complying with the standard, allowing for lower costs and less potential for disruptions of fuel supply. We request comment on whether it would be possible to have a higher cap as long as the average remained essentially unchanged and if so, what cap would be appropriate. If such an approach could enable the technology, we seek comment on the extent to which it would help address the concerns refiners have raised with very low sulfur levels with respect to the potential for fuel shortages and price increases.

If an averaged fuel sulfur standard were to be adopted (at any sulfur level), one added flexibility option that has been suggested to facilitate it is an averaging, banking and trading program. Because we believe that the exhaust emission control devices would require ultra-low sulfur diesel fuel, this flexibility would be focused on the average component of the standard, rather than on the cap component. Refineries would have the option to average across batches, to bank credits for use in the future, and to purchase credits from other refineries. In addition, under this concept the Agency could offer additional ''average credits'' at a predetermined price to refineries. This could provide more certainty about the cost of complying with the average component of the standard by establishing a ceiling price on these tradable and bankable credits. These credits could be used for a refinery to comply with the average requirement; however, refineries' use of these credits would still be subject to the cap standard. We request comment on the concept of an averaging, banking, and trading program in the context of an average standard, including: (1) whether the additional flexibility of offering additional ''average credits'' at a predetermined price would benefit refineries; and, (2) what the appropriate predetermined price for EPA-offered ''average credits'' should be.

4. Why We Believe Our Diesel Fuel Sulfur Program Should Be Year-round and Nationwide

We believe it is necessary for all highway diesel fuel to meet the proposed 15 ppm sulfur limit at all times. To relax this requirement would jeopardize many of the environmental benefits of the proposed program. Although NO_X benefits are only realized in the summer, PM and air toxics benefits are realized year-round. Moreover, the exhaust emission control devices require low-sulfur diesel fuel year-round. The use of highway fuel with a sulfur content greater than our proposed sulfur standard could damage the emission control technology of 2007 and later model year vehicles and engines. Once vehicles are equipped with the new exhaust emission control devices, they can only be fueled with the low-sulfur fuel. This precludes any consideration of a seasonal program. In addition, because diesel vehicles travel across the country transporting goods from region to region and state to state, low-sulfur diesel fuel will have to be available nationwide (see discussion in section VI.C. for possible exceptions. The health effects associated with diesel PM emissions are not area-specific, nor are the adverse effects of high sulfur diesel on engines with exhaust emission control. For these reasons, we do not believe that any regional or seasonal exemptions from the proposed sulfur requirements would be practical.

C. When Would the New Diesel Sulfur Standard Go Into Effect?

Since the need for low-sulfur diesel is dictated by the implementation of new engine standards, the proposed sulfur standard would become effective commensurate with the introduction of the first heavy-duty engines meeting our proposed standards. As described in section III.H, the phase-in of the engine standards is proposed to begin with the 2007 model year. Since light-heavy-duty trucks might be introduced as early as January 2 of the previous calendar year but are often introduced beginning about July 1, we are proposing that all highway diesel fuel sold at retail stations and wholesale purchaser-consumers meet the proposed sulfur standard by June 1, 2006. We believe that this one month lead time will be sufficient to provide confidence that the fuel available for purchase on July 1 will comply with the proposed sulfur cap. We are also proposing that highway diesel fuel at the terminal level be required to meet the proposed sulfur standard as of May 1, 2006, and that highway diesel fuel produced by refiners (and imported) meet the proposed sulfur standard by April 1, 2006. We believe these earlier compliance requirements at terminals and refineries would be necessary to provide an orderly transition to low-sulfur fuel and to avoid the market disruptions that occurred when the sulfur level of diesel fuel was lowered to 500 ppm in 1993 with only a retail compliance date. The three months between April and July should allow sufficient time for fuel to move through the distribution system, for existing tankage to transition down to the lower sulfur level that would be required. It would also ensure that all fuel is complying with the proposed sulfur standard and is available for use in heavy-duty engines when 2007 model year engines are introduced to the market. We request comment on this proposed approach.

We believe that the lead-time issue is particularly important, because not only would failure to meet the standards at the retail level cause emission increases from new technology vehicles, but violations of the standard due to insufficient turnover in the distribution system could potentially permanently disable the emission control systems of new technology vehicles and could cause driveability problems for the operators of such vehicles. We would like to take comment on these dates for the start of our low-sulfur diesel program, and in particular on whether the three-month lead time is more than adequate, adequate, or less than adequate for an orderly transition.

Some parties have suggested that low-sulfur diesel should be required at the same time as low-sulfur gasoline, in 2004. They point out that refinery synergies are optimized when refiners are forced to address both requirements at the same time instead of sequentially. The earlier introduction of low-sulfur diesel would also provide both reductions in sulfur dioxide and sulfate PM emissions for the in-use fleet prior to 2007, and would give engine manufacturers greater flexibility to make use of sulfur-sensitive technologies such as cooled EGR.

We do not believe that it is appropriate to require all on-highway diesel fuel to meet our proposed sulfur standard prior to the introduction of heavy-duty engines meeting our proposed standards. By proposing a 2006 start year for the low-sulfur diesel program, we are giving refiners a long lead-time to begin the planning process for meeting our proposed requirements. They always have the flexibility to make a single set of refinery changes prior to 2004 that will allow them to meet both the low-sulfur gasoline and our proposed low-sulfur diesel requirements by 2004. Although we are not requiring it, we would encourage the introduction of highway diesel fuel that meets the proposed sulfur standard prior to 2006, as discussed in section IV.F.

Finally, some parties have suggested that low-sulfur diesel is necessary by 2004 to ensure that light-duty vehicles can meet our Tier 2 standards using diesel fuel. Although some analysts have predicted a greater proportion of diesel-powered light-duty vehicles in the coming decade, we do not believe that they can justify the introduction of low-sulfur diesel prior to 2006. As discussed in more detail in section VI.A.2, we believe diesel-powered light-duty vehicles will not actually need low-sulfur diesel fuel prior to 2006, given the flexibility offered by the Tier 2 program's bin structure. It would also appear that light-duty vehicles would not produce lower emissions using lower-sulfur diesel fuel than they would using gasoline, since all light-duty must meet the same Tier 2 standards. There would be no emission benefits associated with introducing low-sulfur diesel fuel prior to 2006, for use in light-duty vehicles, and thus it would be difficult to justify the costs. We welcome comments on requiring low-sulfur diesel fuel prior to 2006 for use in light-duty vehicles. We also welcome comments on the appropriateness of a 2006 start date for the diesel fuel sulfur standard.

D. Why We Believe the Proposed Diesel Sulfur Standard Is Technologically Feasible

In addition to evaluating the merits of diesel powered highway vehicles operating on low-sulfur diesel fuel, we also considered the ability of refiners to reduce diesel fuel sulfur in essentially every gallon of highway diesel fuel by mid-2006. Based on this evaluation, we believe it is technically feasible for refiners to meet the proposed standards and that it is possible for them to do so in the proposed time frame. We are summarizing our analysis here and we refer the reader to the Draft RIA for more details. We welcome comments on all aspects of this analysis.

1. What Technology Would Refiners Use?

Conventional diesel desulfurization technologies have been available and in use for many years. Conventional hydrotreating technology involves combining hydrogen with the distillate (material falling into the boiling range of diesel fuel) at moderate pressures and temperatures and flowing the mixture through a fixed bed of catalyst. EPA required refiners and diesel fuel distributors and marketers to provide diesel fuel for highway vehicles which does not exceed 500 ppm by weight in sulfur starting in October 1993. As a result, most U.S. refiners installed diesel desulfurization units to reduce their onroad diesel fuel from the pre-control average of about 3000 ppm, to the current average of about 350 ppm.

Based on our review of the literature and discussions with vendors of catalyst technology and desulfurization technology, the most difficult challenge to reducing sulfur to extremely low levels via conventional hydrotreating is the presence of certain aromatic compounds. These aromatic compounds are referred to as sterically hindered, because the physical arrangement of the atoms of these compounds hinders interaction between the sulfur atom and the catalyst.[128] One method to desulfurize these compounds is to design the shape of catalyst surfaces so that these sterically hindered compounds can more easily approach the catalytic material. Another approach is to saturate one or more of the aromatic rings present, which makes the sulfur atom more accessible to the catalytic surface.

Refiners produce diesel fuel from a variety of distillate blending streams in the refinery. The largest component is straight run distillate, which comes straight from crude oil, hence the name straight run. The second largest component is light cycle oil (LCO) which comes from the fluidized catalytic cracker, or FCC unit. This unit primarily produces gasoline from material having a higher molecular weight than either gasoline or diesel fuel, but also produces a significant amount of distillate. About 62 percent of today's highway diesel fuel contains some LCO. The third largest component is light coker gas oil, which comes from the coker, which also produces lighter molecular weight material from heavier material. Both straight run distillate and light coker gas oil contain relatively low levels of sterically hindered compounds. LCO contains a much higher concentration of sterically hindered compounds. Thus, the difficulty of achieving the 15 ppm sulfur cap being proposed today is primarily a function of the amount of light cycle oil (LCO) that a refiner processes into its highway diesel pool.[129]

We project that all refiners would be technically capable of meeting the proposed sulfur cap with extensions of the same conventional hydrotreating which they are using to meet the current highway diesel fuel standard. This extension would likely mean adding a second stage of conventional hydrotreating. In a two-stage process, hydrogen sulfide is removed from the treated distillate after the first reactor and fresh hydrogen added prior to the second reactor. This stripping of the hydrogen sulfide serves two purposes. First and foremost, it reduces the concentration of hydrogen sulfide throughout the second reactor. This speeds up the desufurization reactions substantially. Second, it reduces the concentration of hydrogen sulfide at the end of the second reactor. This is the point where hydrogen sulfide can react with the treated distillate, forming new sulfur compounds (essentially adding sulfur back into the fuel). This process is termed recombination and low hydrogen sulfide concentrations decrease it dramatically. Finally, reducing the concentration of hydrogen sulfide increases the concentration of hydrogen, again speeding up the desulfurization reactions.

Converting an existing one-stage hydrotreater into a two-stage hydrotreater would involve adding an additional reactor, a hot hydrogen sulfide stripper, modifications to the compressor to increase pressure to the new reactor and possibly a pressure-swing adsorption (PSA) unit to increase hydrogen purity. Essentially all of the units comprising the existing hydrotreater would still be used.

We project that all refiners could utilize recently developed, high activity catalysts, which increase the amount of sulfur which can be removed relative to the catalysts which were available when the current desulfurization units were designed and built. The cost of these advanced catalysts is very modest relative to less active catalysts, but they would significantly reduce the size of the new reactors described above. We also project that refiners and technology vendors could achieve the 15 ppm cap without significant saturation of aromatic compounds. This will be achieved through the selection of catalysts and through the control of operating conditions, particularly temperature.

The above projections are based primarily on information received from a number of refining technology vendors, supported by published literature, as no operating experience at sulfur levels below 10 ppm currently exists with this technology on diesel fuel feedstocks typical of U.S. refiners. All the vendors supplying information to EPA and others studying diesel fuel desulfurization projected that the 15 ppm cap can be met using diesel fuel

[128] Typical compounds which are difficult to desulfurize are 4-methyl, dibenzothiophene and 4,6-dimethyl, dibenzothiophene. The methyl group(s) attached to the aromatic rings make it very difficult for the sulfur atom to physically approach the catalyst, which is essential for the desulfurization process to proceed.

[129] LCOs are not homogeneous and can vary dramatically in chemical composition from refiner to refiner. The discussion here applies to a typical LCO composition.

hydrotreaters which operate at hydrogen pressures ranging from 600–900 pounds per square inch (psi) and with total reactor volumes of roughly 2–3 times those of current diesel fuel hydrotreaters. A number of oil refiners informed us that they believe that much larger reactors would be required. API believes that both higher pressures and larger reactors will be needed. Either change would increase our projected costs (described in section V.D.1 below).

Based on our review of the literature, we do not believe that these extremely large reactors would be required to meet the proposed sulfur cap. However, 15 ppm sulfur diesel fuel is not yet being produced commercially from feedstocks typical of the U.S. Thus, we request comments on the sufficiency of 600–900 psi operating pressures for diesel fuel hydrotreaters to meet the proposed sulfur cap. We also request comment on the sufficiency of total reactor volumes which are 2–3 times greater than those currently being utilized under the 500 ppm sulfur cap in order to meet a 15 ppm cap.

Other options are available to refiners. Some refiners could choose to add an FCC feed hydrotreater. This improves the yield of high value products from the FCC unit and reduces the sulfur content of both FCC naphtha and LCO. FCC naphtha is the primary source of sulfur in gasoline, for which EPA recently set stringent standards. However, while hydrotreating the FCC feed reduces the sulfur content of the LCO produced by the FCC unit, it can increase the concentration of sterically hindered compounds. Also, FCC feed hydrotreating is much more costly than distillate hydrotreating or ring opening technology. Thus, we are not projecting that any refiners would utilize this technology to meet the proposed diesel fuel sulfur cap.

Refiners could also add a hydrocracker to process their LCO if they have not already done so. This would increase the production of high value gasoline with a very low sulfur content. However, hydrocrackers are very costly to build and operate, so a refiner choosing to do so would likely do so for reasons beyond removing sulfur from diesel fuel.

In addition to these major technological options, most refiners would also have to add other more minor units to support the new desulfurization unit. These units could include hydrogen plants, sulfur recovery plants, amine plants and sour water scrubbing facilities. All of these units are already operating in refineries but may have to be expanded or enlarged.

2. Are These Technologies Commercially Demonstrated?

As mentioned above, conventional diesel desulfurization technologies have been available and in use for many years. U.S. refiners have roughly seven years of experience with this technology in producing highway diesel fuel with less than 500 ppm sulfur. Refiners in California also have the same length of experience with meeting the California 500 ppm cap on sulfur and an additional aromatics standard.[130] In order to meet both sulfur and aromatics standards, refineries in California are producing highway and nonroad diesel fuel with an average sulfur level of 150 ppm.

Some refiners in Europe are producing a very low-sulfur, low aromatics diesel fuel for use in the cities in Sweden (Class I Swedish Diesel) using two-stage hydrotreating. This ''Swedish city diesel'' is averaging under 10 ppm sulfur and under 10 volume percent aromatics. While clearly demonstrating the feasibility of consistently producing diesel fuel with less than 10 ppm sulfur from selected feedstocks, there are a few differences between the Swedish fuel and typical U.S. diesel fuel. First, the tight aromatics specification applicable to Swedish City diesel fuel usually requires the use of ring-opening or dearomatization catalysts in the second stage of the two-stage hydrotreating unit. This eases the task of desulfurizing any sterically hindered compounds present. Second, Swedish Class I diesel fuel also must meet a tight density specification. This, coupled with the fact that European diesel fuel contains less LCO than U.S. diesel fuel, significantly reduces the amount of sterically hindered compounds present in the feed to the desulfurization unit. Third, it is not clear whether any refiner is producing a large fraction of their distillate production to this specification. Thus, the European experience demonstrates the efficacy of the two-stage process and its ability to produce very low sulfur diesel fuel. However, doing so without saturating most of the aromatics present and with heavier feedstock has only been demonstrated in pilot plants and not commercially.

Europe has adopted a 50 ppm cap sulfur standard for all diesel fuel which takes effect in 2005. Some countries, including England, have implemented tax incentives for refiners to produce this fuel sooner. The great majority of diesel fuel in England already meets the 50 ppm specification. Refiners have reported no troubles with this technology. This diesel fuel is being produced in one-stage hydrotreaters. However, as mentioned above, European diesel fuel contains less LCO than diesel fuel in the U.S., so the use of one-stage conventional hydrotreating to meet very low sulfur levels is applicable, but not sufficient to demonstrate feasibility in the U.S. Germany has also established a tax incentive, but for diesel fuel containing 10 ppm or less sulfur. One European technology vendor indicated that they have already licensed two desulfurization units to German refiners planning to produce diesel fuel to obtain this tax credit.

Overall, conventional diesel desulfurization ring-opening and dearomatization technologies have all been installed and are operating in one or more refineries. Thus, there should not be much concern among refiners whether these technologies will work reliably in general. Refiners' primary concern would be focused on the treatment of any LCO currently being blended into highway diesel fuel. They would be particularly concerned with the ability to desulfurize this material to very low sulfur levels using conventional technology and, absent that, ways to shift this material to other valuable fuel pools or treat it more severely in available hydrotreaters or hydrocrackers. Of course, refiners would also be concerned with the reliability of the technology in complying with a 15 ppm cap day in and day out.

In addition to these more traditional technologies, Energy Biosystems recently announced the availability of their biodesulfurization technology for desulfurizing diesel fuel. Biodesulfurization is a process which uses bacteria which has been genetically enhanced to biologically remove the sulfur atoms from petroleum compounds. This process is still being developed and is expected to begin commercial demonstration in the next couple of years. At the present time, the goal of the developers is to produce diesel fuel with less than 50 ppm sulfur. It is not known whether this technology would be capable of meeting the proposed cap of 15 ppm. This process has the advantage of operating at ambient temperature and pressures, and requires no hydrogen. The economics of the process, however, rely on a market for its by-products, which may limit its widespread application. Because of

[130] California allows refiners to use an engine test to certify an alternative fuel mixture which meets or exceeds the NOx reducing performance of a 10 volume percent maximum aromatics and a 500 ppm maximum sulfur diesel fuel.

uncertainties in this technology's ability to achieve the proposed 15 ppm cap, we did not factor it into our cost projections. We request comment on the availability of this technology in the relevant time frame for this proposed rulemaking.

3. Are There Unique Concerns for Small Refiners?

We have heard concerns that small refiners would bear proportionately higher economic burdens if they were required to produce diesel fuel meeting the same sulfur levels as larger refineries. The most significant concern expressed to us has been their more limited ability to obtain the capital necessary to make the refinery modifications necessary to produce low sulfur diesel fuel compared to the larger refiner. To address these and other concerns related to small refiners, we have participated in a review and evaluation process specific to small businesses under the Small Business Regulatory Enforcement Flexibility Act (SBREFA). More information can be found in our response to the Regulatory Flexibility Act (see section XI.B). In short, we are seeking comment on provisions that would assist small refiners in addressing unique challenges, as discussed in section VIII.E.

4. Can Refiners Comply with an April 1, 2006 Start Date?

We believe that our proposal that the program begin on April 1, 2006 would provide more than an adequate amount of time for refiners to plan their investment, complete the design package and complete the construction and startup of the new or modified desulfurization unit and other associated units in their refineries. In response to our proposed Tier 2 gasoline desulfurization rulemaking, the American Petroleum Institute (API) commented that 4 years is needed for refiners to complete this cycle of planning, design, construction and startup. While we believe 4 years to be more than sufficient, we have initiated this rulemaking sufficiently early to provide over 5 years of lead time. We recognize that most refiners will have to make investments in their refineries to desulfurize their gasoline during this time, so the additional time from final rule to implementation is expected to be valuable for refiners. Similarly, by informing refiners now (i.e., before they make their gasoline desulfurization investments) of our proposed highway diesel fuel desulfurization program we hope to allow refiners to coordinate their investments and produce both low-sulfur gasoline and low-sulfur onroad diesel at a lower cost. The additional time between promulgation and implementation is important because of the number of refiners which are expected to have to make these investments. Unlike the gasoline sulfur program which really only affected refineries outside of California, this program would affect the California refiners as well, in addition to a number of refineries which produce onroad diesel fuel but no gasoline.[131] However, the total capital cost of the investments projected to be required to meet the proposed diesel fuel sulfur cap is less than that for the Tier 2 gasoline sulfur standards.

A particular concern has been raised to the Agency regarding the capability of the engineering and construction (E&C) industries to be able to design and build diesel fuel hydrotreaters while at the same time doing the same for gasoline, as well as accomplishing their other objectives. We believe that the E&C industry is capable of supplying the oil refining industry with the equipment necessary to comply with the proposed diesel fuel sulfur cap on time.[132] We believe that this is facilitated by the extended phase-in we allowed regarding compliance with the Tier 2 gasoline sulfur standards. For example, we project that only roughly a third of all gasoline-producing refineries outside of California will be building gasoline desulfurization equipment for start-up in early 2006 and 2007. Thus, most of the construction related to gasoline desulfurization will be completed prior to the proposed implementation of the diesel fuel sulfur cap. Also, low sulfur gasoline and diesel fuel standards scheduled for Europe and Canada become effective in 2005. We believe that this precedes the proposed highway diesel fuel sulfur cap sufficiently to enable the availability of European equipment fabrication capacity to be available to meet the needs of the proposed sulfur cap in the U.S. Thus, we do not foresee any shortage in either E&C industry personnel or equipment fabrication capacity. We request comment on these findings.

We are aware that the National Petroleum Council (NPC) is conducting a Refining Study which also addresses this issue. It appears from a publically available draft final report that the NPC may conclude otherwise. We plan to consider the findings of this study once it becomes final.

Another issue related to the feasibility of the April 1, 2006 start date relates to refiners' ability to hook up their new equipment to their existing diesel fuel hydrotreaters while still providing the nation with diesel fuel during the transition. This issue is relevant since: (1) we expect most refiners to revamp their current equipment, as opposed to building entirely new equipment and (2) all refiners face the same April 1, 2006 deadline. We expect that any new equipment required as part of the revamp would be able to be constructed on-site while the current equipment is operating. Inter-connecting the new and old equipment would occur prior to April 2006 when the current hydrotreater is scheduled to be down for maintenance. Existing equipment which would require modification, such as compressors and heat exchangers, would be modified during this time, as well. Diesel fuel hydrotreaters currently operate roughly two years in between scheduled maintenance. Thus, there should be at least one and possibly two scheduled maintenance periods between the time when refiners could have project designs completed, permits issued, as appropriate, and April 2006. Under this schedule of refinery maintenance, modifying current diesel fuel hydrotreaters to meet the proposed sulfur cap should not impact diesel fuel production. If refiners had to schedule additional down time in order to complete the revamp, then diesel fuel production could be affected. We expect that any such shortfall would be made up by other refiners or the previous build-up of inventory. We request comment on the ability of the industry to continue to supply highway diesel fuel while it is modifying equipment in order to comply with the proposed sulfur cap.

Concerns have also been raised with respect to the refining industry's ability to raise the capital necessary to make the refinery modifications necessary to meet a 15 ppm sulfur cap on diesel fuel, while at the same time expending capital to reduce the sulfur level in gasoline as a result of the recently promulgated Tier 2 standards. This has led to concerns that some refiners may refrain from investing to continue to produce highway diesel fuel, which could cause a shortage when the program is implemented. As discussed in section IV.B. of the draft RIA, we have designed these programs in a

[131] By far most of California gasoline meets a 30 ppm averaging standard, except for a small volume which is exported out of the state. However, since the California refiners already have the desulfurization units in place to desulfurize the majority of their gasoline, they are expected to use those same units to desulfurize the exported gasoline as well.

[132] Rykowski, Richard A., ''Implementation of Ultra Low Sulfur Diesel Fuel: Construction Capacity and Aggregate Capital Investment,'' EPA Memorandum to the Record, Docket A–99–06.

manner which will serve to maximize refiner flexibility and minimize costs. Furthermore, as discussed in section V.D.1., we believe that despite the capital cost of desulfurizing their highway diesel fuel, other options for marketing the distillate streams from their refineries will be limited. Finally, as discussed in section VI.A., we are also considering various phase-in approaches for implementing the low sulfur diesel standard. A phase-in could help spread out the design, construction, and capital expenditure of refinery modifications necessary to comply with the proposed diesel fuel sulfur standard. We request comment on the necessity and ability of a phase-in to address these concerns.

In summary, we believe that meeting a 15 ppm cap is achievable with the diesel desulfurization technologies available now. We are confident that we are providing more than a sufficient amount of time between when this rule is expected to be finalized and the proposed startup date of the program. This timing should allow for a smooth transition of low-sulfur fuel into the marketplace. We request comments on all of these issues. In particular, we request comment and supporting information on the challenges refiners would face in competing for engineering and construction resources and obtaining capital for diesel fuel sulfur control. We also seek comment with supporting information on the potential for diesel fuel shortages at the beginning of the program that some believe might result from individual refinery decisions to shift all or a portion of their production to other distillate products or export, and on the ability of the market to self correct if a shortage does occur.

5. Can a 15 ppm Cap on Sulfur Be Maintained by the Distribution System?

The proposed cap on sulfur content would apply to on-highway diesel fuel at the refinery gate, and at every point along the distribution system through to the end-user. The current distribution system for petroleum distillates currently carries products with sulfur contents that range from 30 ppm to over 10,000 ppm. The system includes pipelines, tankers, tanks, and delivery trucks. To date, this system has not been required to deliver a product with the purity which would be required under this proposal. Consequently, to ensure the sulfur standard is not exceeded during the fuel's journey to the end-user, the refiner would actually produce diesel fuel sufficiently below the cap to account for its own compliance margin (estimated to be 7 ppm on average), as well as for test variability and potential downstream contamination. Under the current sulfur cap of 500 ppm, refiners typically provide ample margin, producing fuel with roughly 350 ppm sulfur. With a sulfur cap of 15 ppm, the absolute magnitude of the margin refiners could provide would obviously be much smaller. In addition, the impact of contamination in the distribution system would be potentially much more severe. If the proposed 15 ppm cap on the sulfur content of on highway diesel fuel were adopted, other products in the distribution system such as nonroad diesel fuel would have sulfur concentrations over 200 times that of highway diesel fuel instead of the 10-fold factor at present. Additives to diesel fuel added in small amounts downstream which sometimes contain high sulfur concentrations levels may also become much more of a concern (see section IV.D.6.c). If as expected, refiners would produce highway diesel fuel with an average sulfur content of approximately 7 ppm to comply with the proposed sulfur standard, and variability in measuring diesel sulfur content is limited to less than +/−4 ppm, downstream sulfur contamination would need to be limited to less than 3 ppm to maintain compliance with the proposed 15 ppm cap. Petroleum marketers and distributors have cautioned that the distribution system is unfamiliar with limiting sulfur contamination to such a low level.

Current industry practices may need to be modified to control and limit sulfur contamination in the distribution system. Current practices which are critical to minimizing contamination and which may need to be more carefully performed include:

—Properly leveling tank trucks to ensure that they can drain completely of high-sulfur product prior to being filled with the proposed diesel fuel.
—Allowing sufficient time for transport tanks to drain of high-sulfur product prior to being filled with the proposed diesel fuel.
—Purging delivery hoses of higher sulfur product prior to their use to deliver the proposed diesel fuel.

To adequately limit sulfur contamination, we believe that such practices would need to be followed each and every time with adequate care taken to ensure their successful and full completion. Some distributors may find it necessary to conduct an employee education program to emphasize their importance. We request comment on our assessment for each segment in the distribution chain, including tank trucks, tank wagons, rail tankers, barges, and marine tankers.

As discussed in section V.D.3 of today's document, there may be an increase in distribution costs associated with an increase in pipeline interface volumes and the need to sample and test each batch of on highway diesel fuel at the terminal level for its sulfur content. There could also be an increase in the occurrence of noncomplying fuel showing up in the distribution system. As is the case today, this could cause temporary, local market shortages of fuel meeting the proposed sulfur cap. This off-specification fuel would also either have to be downgraded to off-highway, or re-refined, though we have assumed that the frequency of such occurrence would be low enough as to not impact the costs of the program noticeably. The potential sources of sulfur contamination in the distribution system, what controls we believe would be necessary to ensure downstream compliance with the proposed sulfur standard, and the costs associated with such controls are discussed in more detail in the Draft RIA. We request comment on the challenges that each segment of the distribution chain would face in controlling sulfur contamination, on the extent that each segment might reasonably be expected to limit sulfur contamination, and on the associated costs.

6. What Are the Potential Impacts of the Proposed Sulfur Change on Lubricity, Other Fuel Properties, and Specialty Fuels?

a. What Is Lubricity and Why Might It be a Concern?

Diesel fuel lubricity properties are depended on by the engine manufacturers to lubricate and protect moving parts within fuel pumps and injection systems for reliable performance. Unit injector systems and in-line pumps, commonly used in heavy-duty engines, are actuated by cams lubricated with crankcase oil, and have minimal sensitivity to fuel lubricity. However, rotary and distributor type pumps, commonly used in light and medium-duty diesel engines, are completely fuel lubricated, resulting in high sensitivity to fuel lubricity.

Experience has shown that it is very rare for a naturally high-sulfur fuel to have poor lubricity, although, most studies show relatively poor overall correlation between sulfur content and lubricity. Considerable research remains to be performed for a better understanding of the fuel components most responsible for lubricity.

Consequently, we are uncertain about the impact of today's proposal on fuel lubricity. Nevertheless, there is evidence that the typical process used to remove sulfur from diesel fuel (hydrotreating) can impact lubricity depending on the severity of the treatment process and characteristics of the crude. If refiners use hydrotreating to achieve the proposed sulfur limit, there may be reductions in the concentration of those components of diesel fuel which contribute to adequate lubricity. As a result, the lubricity of some batches of fuel may be reduced compared to today's levels, resulting in an increased need for the use of lubricity additives in highway diesel fuel.

Blending small amounts of lubricity-enhancing additives increases the lubricity of poor-lubricity fuels to acceptable levels. At the present time, it is believed that oil companies are treating diesel fuel in this way on a batch to batch basis, when poor lubricity fuel is expected. This practice of treating fuel on an as-needed and voluntary basis has been effective in ensuring good diesel fuel lubricity for the diesel heavy-duty vehicle fleet. Our review of the technical literature [133] indicates that the U.S. military also uses lubricity-enhancing additives in its diesel fuel. The U.S. military has found that the traditional corrosion inhibitor additives that it uses have been highly effective in reducing fuel system component wear. Consequently, the U.S. Army now blends MIL–I–25017E corrosion inhibitor additive to all fuels when poor lubricity is expected, and regularly for Jet A–1, JP–5 and JP–8 fuels. We believe that this practice would continue, with some portion of the fuel refined to the proposed standard being treated with lubricity-enhancing additives. For a more detailed discussion of diesel fuel lubricity and current industry practices, please refer to the Draft RIA for this proposal. We have included a 0.2 cents per gallon cost in our calculations to account for the potential increased use of lubricity additives (see section V.D.2).

b. Voluntary Approach for the Maintenance of Fuel Lubricity

If action on fuel lubricity does prove necessary, we believe a voluntary approach would provide customer protection from engine failures due to low lubricity, while providing the maximum flexibility for industry. In a voluntary approach we would encourage, but not require, fuel producers and distributors to monitor and provide fuel with adequate lubricity to protect diesel engine fuel systems. This approach recognizes the uncertainties of measuring fuel lubricity, and allows flexibility as research produces better information and improved test methods. The voluntary approach discussed here would be a continuation of current industry practices for diesel fuel produced to meet the current Federal and California 500 ppm sulfur diesel fuel specifications, and benefits from the considerable experience gained since 1993. The advantage of this approach is avoidance of an additional regulatory scheme and associated burdens. On the down side, voluntary measures do not guarantee results. We believe the risk in this case is small. Refiners and distributors have an incentive to supply fuel products that will not damage consumer equipment. Even if occasional batches of poor lubricity fuel are distributed, they would likely be "treated" with residual quantities of good lubricity fuel in storage tanks, tanker trucks, retail tanks, and vehicle fuel tanks (even at very low treatment levels lubricity enhancing additives provide significant protection; see the discussion in the Draft RIA for this proposal). Further, we expect that the American Society for Testing and Materials intends to address lubricity in its ASTM D–975 specifications for diesel fuel quality after its concerns about test issues have been resolved.

We are asking for comments on the alternative of specifying minimum fuel lubricity, and suggestions for the appropriate lubricity standard and test method. Under this approach, we would require fuel producers to monitor and provide minimum lubricity. This would be similar to the approach of Canada and our understanding of the usage requirements of the U.S. military. The advantage of this approach is to guarantee the minimum quality of fuel in the market. On the down side, such a new specification would need to be tied specifically to emissions or emission control hardware, and we question whether such a requirement is appropriate considering the uncertainty about the adequacy of the existing test methods. The American Society for Testing and Materials has declined to specify a lubricity standard in its ASTM D–975 specifications for diesel fuel quality until its concerns about test issues have been resolved. Also, this approach would require an enforcement scheme and associated compliance burden. Further, we believe that this approach would probably not be significantly more effective than the voluntary approach. Refiners and distributors have an incentive to supply fuel products that will not damage consumer equipment, and the U.S. commercial market has adequately addressed similar concerns in the past.

The U.S. Department of Defense (DOD) expressed strong reservations about the ability of the proposed voluntary approach to ensure adequate fuel lubricity and requested that EPA establish a uniform requirement to ensure that diesel fuel introduced into commerce has adequate lubricity. Absent such a requirement, DOD related that the military would face a considerable burden to ensure that highway diesel fuel used in military vehicles provides sufficient lubricity. DOD stated that since they rely on the commercial market to supply highway diesel to military users and are currently experiencing lubricity problems in certain parts of the country during the winter months, a reduction in diesel sulfur would increase the risk and scope of lubricity problems. DOD also stated that due to harsher operating conditions, engines used in their vehicles (especially tactical vehicles) are more vulnerable to lubricity problems than the same engines operated in commercial vehicles. In addition, at some U.S. military installations DOD uses highway diesel fuel in their off highway vehicles as well as their highway vehicles. We request comment on the unique challenges that our proposed voluntary approach would place on the military and on the appropriate means to address DOD's concerns.

c. What Are the Possible Impacts of Potential Changes in Fuel Properties Other Than Sulfur on the Materials Used in Engines and Fuel Supply Systems?

With the introduction of low-sulfur diesel fuel in the United States in 1993, some diesel engine fuel pumps with a Nitrile material for O-ring seals began to leak. Fuel pumps using a Viton material for the seals did not experience leakage. The leakage from the Nitrile seals was determined to be due to low aromatics levels in some low-sulfur fuel, not the low sulfur levels. In the process of lowering the sulfur content of some fuel, some of the aromatics had been removed. Normally, the aromatics in the fuel penetrate the Nitrile material and cause it to swell, thereby providing a seal with the throttle shaft. When low-aromatics fuel is used after conventional fuel has been used, the aromatics already in the swelled O-ring will leach out into the low-aromatics fuel.

[133] See the draft RIA for a more detailed discussion.

Subsequently, the Nitrile O-ring will shrink and pull away, thus causing leaks, or the stress on the O-ring during the leaching process will cause it to crack and leak. Not all low-sulfur fuels caused this problem, because the amount and type of aromatics varied. Although manufacturers have apparently resolved this issue, and we have no evidence that further desulfurization will cause further changes in O-ring shape or other concerns, we request comments on this or other potential impacts of fuel properties on the materials used in engines and fuel supply systems.

d. What Impact Would the 15 ppm Cap Have on Diesel Performance Additives?

Our proposal to limit the sulfur content of performance additives used in diesel fuel to less than 15 ppm (see section VIII) would require that the use of certain high-sulfur diesel fuel additives be discontinued. Our review of EPA's Fuel and Fuel Additives database indicates that alternative additives that perform the same function and which do not contain sulfur are readily available. Our evaluation suggests that discontinuing the use of the limited number of diesel additives with a high sulfur content would not result in significant increased costs or an undue hardship to additive and fuel manufacturers (see the draft RIA). We request comment on the difference in price between high- and low-sulfur performance additives and whether there are differences in their efficiency. As an alternative to the proposed 15 ppm cap on the sulfur content of performance additives, we are requesting comment on whether additives not meeting the 15 ppm sulfur cap should be allowed to be added to diesel fuel downstream in de minimis amounts, as long as the final blend still meets the 15 ppm cap.

e. What Are the Concerns Regarding the Potential Impact on the Availability and Quality of Specialty Fuels?

The Department of Defense (DOD) has expressed concerns regarding the potential impact of today's proposed rule on the availability and quality of military fuels, especially the aviation fuels JP–5 and JP–8. DOD is concerned that today's rule might reduce the number of refineries that produce military fuels by limiting the slate of fuels that refiners can economically produce or the number of refiners that continue to produce military fuels. DOD notes that the special flash point requirement for military JP–5 fuel already limits DOD's supply base and that the proposed rule may make some refiners opt out of manufacturing this speciality fuel, which would reduce supply availability and increase costs. DOD also states that the increased hydroprocessing severity and other refinery process modifications necessary to meet the proposed sulfur standard could impact certain chemical/physical characteristics that are part of their fuel specifications. DOD relates that previous environmentally-driven changes to gasoline and diesel specifications have caused a degradation in the quality of the jet fuel. For example, DOD states that they have noticed a reduction and continued decline in jet fuel stability.

DOD is also concerned that refiners that currently blend more than 10 percent light cycle oil (LCO) into their highway diesel fuel might shift some LCO into off-highway distillate fuels. DOD relates that this would adversely affect the quality of off highway fuels used by the military such as their naval distillate fuel F–76. DOD states that they have experienced quality problems with LCO component streams that were not adequately hydrotreated causing a highly unstable finished product. Storage stability is an important issue for DOD since military naval fuel F–76 is often stored for extended periods (longer than six months) and unstable LCO used to manufacture F–76 could compromise mission readiness. The potential changes that refiners might make in the way they process LCO streams and incorporate such streams into their slate of distillate fuels is discussed in section V.D.1 and in the Draft RIA.

We believe that concerns related to the quality of specialty fuels can continue to be addressed by actions taken by the manufacturers and purchasers of such fuels without the need for intervention by EPA. We also anticipate that demand for such fuels will be sufficient to encourage their continued availability. We request comment on the potential impact of today's proposed rule on the quality and availability of specialty fuels such as those used by the U.S. military, on what actions might be necessary to mitigate such impacts, and on the associated costs. Comment is specifically requested on the need for the military to modify its specifications and/or enhance enforcement of these specifications to achieve their fuel quality goals if the proposed sulfur standards are adopted, and on the costs associated with such changes.

E. Who Would Be Required to Meet This Proposed New Diesel Sulfur Standard?

As discussed earlier, the highway diesel fuel sulfur content standard being proposed today is a per-gallon cap of 15 ppm. We believe that heavy-duty diesel trucks subject to the standards we are proposing today would require the consistent use of diesel fuel with a sulfur cap of 15 ppm to avoid the potentially severe emission, performance, and durability problems that arise from operation on higher-sulfur fuel. On this basis we believe that the proposed sulfur standard should apply to the diesel fuel at the point of sale to the ultimate consumer. In other words, the proposed cap on sulfur content should apply at all points in the diesel fuel production and distribution system, including the retail level.

We understand that there are production and distribution practices, such as blending of additives and winter viscosity improvers such as kerosene or No. 1 diesel fuel, that could cause the sulfur level of diesel fuel to vary as it travels from refinery to end-point consumers. Along with concerns about contamination and test method reproducibility, these issues suggest that we should include some sort of tolerance along with our proposed sulfur cap. However, we are concerned that such tolerances on top of the 15 ppm cap may not be appropriate given the sensitivity of diesel exhaust emission control technology to fuel sulfur above the proposed sulfur cap. In practice, therefore, refiners will likely be required by the downstream distribution system to produce diesel fuel having a sulfur content significantly below the proposed sulfur cap to ensure that downstream practices do not end up producing a retail-level fuel with sulfur levels higher than the proposed maximum. Thus, all parties in the distribution system, including refiners and importers, would be prohibited from selling, storing, transporting, dispensing, introducing, or causing or allowing the introduction of highway diesel fuel whose sulfur content exceeds the proposed sulfur cap. The advantage of such an approach is that, as downstream distribution practices and sulfur measurement accuracy improves, refiners will be able to reduce production costs by producing fuel closer to the proposed sulfur cap. Alternatively, we could enforce the proposed 15 ppm sulfur cap at retail and enforce a lower cap at the refinery level. This cap would likely have to be less than 10 ppm to allow for downstream contamination, additive blending, and test method variability.

However, we believe it is more appropriate to leave this tolerance to the market.

F. What Might Be Done To Encourage the Early Introduction of Low-Sulfur Diesel Fuel?

As discussed in section IV.C, we are proposing that the entire highway diesel pool be required to meet a lower standard on sulfur content beginning June 1, 2006.[134] This should provide certainty that low-sulfur diesel fuel will be available for model year (MY) 2007 heavy-duty diesel engines by July 1, 2006. If low-sulfur diesel fuel was available prior to July 1, 2006, engine manufacturers have indicated that fleet trials might be conducted of the sulfur-sensitive exhaust emission control equipment intended for use in heavy-duty vehicles to meet the proposed MY 2007 emissions standards. The information gained from these trials could be used to improve the efficiency and durability of such exhaust emission control equipment. This could lower the cost of the exhaust emission control equipment and help ensure the smooth implementation of the proposed MY 2007, heavy-duty standards. If low-sulfur diesel fuel was available earlier than July 1, 2006, it might also facilitate the early introduction of sulfur-sensitive exhaust emission control equipment in light-duty diesel vehicles. Automobile manufacturers expressed interest in using sulfur-sensitive exhaust emission control equipment in some of their light-duty vehicles beginning in MY 2004, so that they might benefit from in-use experience prior to the anticipated use of such equipment in all MY 2007, light-duty diesel vehicles. In addition, early availability of some low sulfur diesel fuel would have the added advantage of allowing the distribution system a chance to develop experience handling diesel fuel with such a low sulfur level before the standards would take effect.

We believe that some low-sulfur diesel fuel meeting the proposed 15 ppm sulfur cap would be available in advance of when we are proposing that it must be produced by refiners. Most refiners will need to install new equipment to meet the proposed sulfur standard. Since the technical and construction resources needed for such refinery upgrades is limited, a number of refiners are likely to have the new desulfurization equipment installed well in advance of the proposed compliance date. Refiners who produce low-sulfur diesel early would want to market it as a premium fuel rather than losing the added value by selling it as current highway diesel fuel. Some refiners have already begun programs to market low-sulfur diesel as a premium fuel. For example, ARCO Products Company recently announced a fleet program to demonstrate the emissions benefits of its EC–-D (emission control) diesel which has a lower sulfur and aromatics content, and a higher cetane rating than current highway diesel fuel.[135] Engine and vehicle manufacturers are assisting in the overall program design and implementation of the program. Emission control equipment manufacturers are supplying exhaust emission control equipment which works more effectively with low-sulfur fuel. ARCO has also begun marketing diesel fuel in California with a maximum sulfur content of 15 ppm. This fuel is being made available, upon request, to operators of urban municipal fleets retrofitted with catalytic exhaust emission controls in connection with the California ARB's proposed urban bus program (see section I.C.6). [136] Mobil Corporation, Ford Motor Company, Navistar, and Volkswagen also have a cooperative program underway to evaluate the emissions benefits of new engine/aftertreatment technologies using a lower-sulfur diesel fuel (also with reduced polynuclear aromatic content). We are interested in encouraging additional programs between refiners and vehicle manufacturers to introduce vehicles equipped with exhaust emission control technologies which benefit from the use of low-sulfur diesel fuel prior to the date when we are proposing that such fuel must be made available.

There are numerous strategies involving voluntary market incentives that could help promote the early introduction of low-sulfur diesel fuel. Under existing voluntary emission credits programs, a system might be created whereby refiners that produce low-sulfur fuel early could generate emission reduction credits that could then be sold through a market mechanism to other entities that could use such credits to meet their emission compliance goals. We welcome comments on whether additional incentives are needed and feasible to encourage the early introduction of low-sulfur diesel fuel for use in vehicles equipped to provide lower emissions with the use of such a fuel. We also request comments on how such incentives might be structured under a phase in of low sulfur highway diesel fuel (see section VI.A).

V. Economic Impact

This section discusses the projected economic impact and cost effectiveness of the proposed emission standards and low-sulfur fuel requirement. We welcome comment on the estimated cost for research and development and the necessary lead time to develop these technologies for heavy-duty vehicles. Additionally we invite the reader to review all of the underlying cost assumptions made in the accompanying draft RIA and ask for comment on the validity of these assumptions. Full details of our cost and cost effectiveness analyses can be found in the Draft RIA.

A. Cost for Diesel Vehicles To Meet Proposed Emissions Standards

1. Summary of New System and Operating Costs

The technologies described in section III show a good deal of promise for controlling emissions, but also make clear that much effort remains to develop and optimize these new technologies for maximum emission-control effectiveness with minimum negative impacts on engine performance, durability, and fuel consumption. On the other hand, it has become clear that manufacturers have a great potential to advance beyond the current state of understanding by identifying aspects of the key technologies that contribute most to hardware or operational costs or other drawbacks and pursuing improvements, simplifications, or alternatives to limit those burdens. To reflect this investment in long-term cost savings potential, the cost analysis includes an estimated $385 million in R&D outlays for heavy-duty engine designs and $220 million in R&D for catalysts systems giving a total R&D outlay for improved emission control of more than $600 million. The cost and technical feasibility analyses accordingly reflect substantial improvements on the current state of technology due to these future developments.

Estimated costs are broken into additional hardware costs and life-cycle operating costs. The incremental hardware costs for new engines are comprised of variable costs (for hardware and assembly time) and fixed costs (for R&D, retooling, and certification). Total operating costs include the estimated incremental cost for low-sulfur diesel fuel, any expected

[134] This is the proposed retail-level compliance date. The proposed compliance date at the refinery level is April 1, 2006.

[135] ARCO Products Company news release dated October 7, 1999, Docket A–99–06 Item II–G–13.

[136] ARCO Products Company news release dated December 15, 1999.

increases in maintenance cost, or fuel consumption costs along with any decreases in operating cost expected due to low-sulfur fuel. Cost estimates based on these projected technology packages represent an expected incremental cost of engines in the 2007 model year. Costs in subsequent years would be reduced by several factors, as described below. Separate projected costs were derived for engines used in three service classes of heavy-duty diesel engines. All costs are presented in 1999 dollars.

The costs of these new technologies for meeting the proposed 2007 model year standards are itemized in the Draft RIA and summarized in Table V.A–1. For light heavy-duty vehicles, the cost of a new 2007 model year engine is estimated to increase by $1,688 and operating costs over a full life-cycle to increase by about $431. For medium heavy-duty vehicles the cost of a new engine is estimated to increase by $2,213, with life-cycle operating costs increasing to $826. Similarly, for heavy heavy-duty engines, the vehicle cost is expected to increase by $2,768, and estimated additional life-cycle operating costs are $3,362. The higher incremental increase in operating costs for the heavy heavy-duty vehicles is due to the larger number of miles driven over their lifetime (714,000 miles on average) and their correspondingly high lifetime fuel usage. Emission reductions are also proportional to VMT and so are significantly higher for heavy heavy-duty vehicles.

We also believe there are factors that would cause cost impacts to decrease over time, making it appropriate to distinguish between near-term and long term costs. Research in the costs of manufacturing has consistently shown that as manufacturers gain experience in production, they are able to apply innovations to simplify machining and assembly operations, use lower cost materials, and reduce the number or complexity of component parts.[137] Our analysis, as described in more detail in the draft RIA, incorporates the effects of this learning curve by projecting that the variable costs of producing the low-emitting engines decreases by 20 percent starting with the third year of production (2009 model year) and by reducing variable costs again by 20 percent starting with the fifth year of production. We invite comment on this methodology to account for the learning curve phenomena and also request comment on whether learning is likely to reduce costs in this industry. Additionally, since fixed costs are assumed to be recovered over a five-year period, these costs are not included in the analysis after the first five model years. Finally, manufacturers are expected to apply ongoing research to make emission controls more effective and to have lower operating cost over time. However, because of the uncertainty involved in forecasting the results of this research, we have conservatively not accounted for it in this analysis. Table V.A–1 lists the projected costs for each category of vehicle in the near- and long-term. For the purposes of this analysis, ''near-term'' costs are those calculated for the 2007 model year and ''long term'' costs are those calculated for 2012 and later model years.

We welcome comment on the degree to which this program may influence sales of new heavy-duty vehicles in the early years of the program, and the resulting impact this would have on our projected program benefits and costs. Costlier model year 2007 vehicles may induce some potential purchasers of these vehicles to instead buy 2006 models to save money, or to defer a purchase longer than they otherwise might have. On the other hand, we would anticipate that the very low emissions characteristics of these new vehicles would cause many buyers for whom cleaner diesels would be good for business (for example, urban transit authorities and touring or shuttle services) to retire older higher-emitting vehicles early.

TABLE V.A–1.—PROJECTED INCREMENTAL SYSTEM COST AND LIFE CYCLE OPERATING COST FOR HEAVY-DUTY DIESEL VEHICLES

[Net present values in the year of sale, 1999 dollars]

Vehicle class	Model year	Hardware cost	Life-cycle operating cost*
Light heavy-duty	Near term	$1,688	$431
	Long term	982	413
Medium heavy-duty	Near term	2,213	826
	Long term	1,188	800
Heavy heavy-duty	Near term	2,768	3,362
	Long term	1,572	3,265
Urban Bus	Near term	2,268	3,942
	Long term	1,252	3,874

*Incremental life-cycle operating costs include the incremental costs to refine and distribute low sulfur diesel fuel, the service cost of closed crankcase filtration systems, and the lower maintenance costs realized through the use of low sulfur diesel fuel (see discussion in section V.3).

2. New System Costs for NO_X and PM Emission Control

Several new technologies are projected for complying with the proposed 2007 model year emission standards. We are projecting that NO_X adsorbers and catalyzed diesel particulate filters would be the most likely technologies applied by the industry in order to meet our proposed emissions standards. The fact that manufacturers would have several years before implementation of the proposed new standards ensures that the technologies used to comply with the standards would develop significantly before reaching production. This ongoing development could lead to reduced costs in three ways. First, we expect research will lead to enhanced effectiveness for individual technologies, allowing manufacturers to use simpler packages of emission control technologies than we would predict given the current state of development. Similarly, we anticipate that the continuing effort to improve the emission control technologies will include innovations that allow lower-

[137] ''Learning Curves in Manufacturing,'' Linda Argote and Dennis Epple, Science, February 23, 1990, Vol. 247, pp. 920–924.

cost production. Finally, we believe that manufacturers would focus research efforts on any drawbacks, such as fuel economy impacts or maintenance costs, in an effort to minimize or overcome any potential negative effects.

We anticipate that in order to meet the proposed standards, industry would introduce a combination of primary technology upgrades for the 2007 model year. Achieving very low NO_X emissions will require basic research on NO_X emission control technologies and improvements in engine management to take advantage of the exhaust emission control system capabilities. The manufacturers are expected to take a systems approach to the problem optimizing the engine and exhaust emission control system to realize the best overall performance possible. Since most research to date with exhaust emission control technologies has focused on retrofit programs there remains room for significant improvements by taking such a systems approach. The NO_X adsorber technology in particular is expected to benefit from re-optimization of the engine management system to better match the NO_X adsorbers performance characteristics. The majority of the $600 million dollars we have estimated for research is expected to be spent on developing this synergy between the engine and NO_X exhaust emission control systems. PM control technologies are expected to be less sensitive to engine operating conditions as they have already shown good robustness in retrofit applications with low-sulfur diesel fuel.

The NO_X adsorber system that we are anticipating would be applied in 2007 consists of a catalyst which combines traditional gasoline three-way conversion technology with a newly developed NO_X storage function, a reductant metering system and a means to control engine air fuel (A/F) ratio. The NO_X adsorber catalyst itself is a relatively new device, but is benefitting in its development from over 20 years of gasoline three-way catalyst development. In order for it to function properly, a systems approach that includes a reductant metering system and control of engine A/F ratio is also necessary. Many of the new air handling and electronic system technologies developed in order to meet the 2004 heavy-duty engine standards can be applied to accomplish the NO_X adsorber control functions as well. Some additional hardware for exhaust NO_X or O_2 sensing and for fuel metering will likely be required. We have estimated that this additional hardware will increase new engine costs by approximately $350 for a heavy heavy-duty diesel engine. The Draft RIA also calculates an increase in warranty costs for this additional hardware. In total the new NO_X control technologies required in order to meet the proposed 2007 emission standards are estimated to increase light heavy-duty engine costs by $890, medium heavy-duty engine costs by $1,047 and heavy heavy-duty engine costs by $1,410 in the year 2007. In the year 2012 and beyond the incremental costs are expected to decrease to $570 for a light heavy-duty engine, $670 for a medium heavy-duty engine and to $902 for a heavy heavy-duty engine.

Catalyzed diesel particulate filters are experiencing widespread retrofit use in much of Europe as low-sulfur diesel fuel becomes readily available. These technologies are proving to be robust in their non-optimized retrofit applications requiring no modification to engine or vehicle control functions. We therefore anticipate that catalyzed diesel particulate filters can be integrated with new diesel engines with only a minimal amount of engine development. We do not anticipate that additional hardware beyond the diesel particulate filter itself and an exhaust pressure sensor for OBD will be required in order to meet the proposed PM standard. We estimate in 2007 that diesel particulate filter systems will add $633 to the cost of a light heavy-duty vehicle, $796 to the cost of a medium heavy-duty vehicle and $1,028 to the cost of a heavy heavy-duty vehicle. By 2012 these costs are expected to decrease to $389, $491, and $638 respectively. These cost estimates are comparable to estimates made by the Manufacturers of Emission Controls Association for these technologies.[138]

We have proposed to eliminate the exemption that allows turbo-charged heavy-duty diesel engines to vent crankcase gases directly to the environment, so called open crankcase systems, and have projected that manufacturers will rely on engineered closed crankcase ventilation systems which filter oil from the blow-by gases. We have estimated the initial cost of these systems in 2007 to be $37, $42, and $49 for light, medium and heavy heavy-duty diesel engines respectively. Additionally we expect a portion of the oil filtration system to be a service replacement oil filter which will be replaced on a 30,000 mile service interval with a service cost of $10, $12, and $15 for light, medium, and heavy heavy-duty diesel engines respectively. These cost are summarized with the other cost for emission controls in Table V.A–1 and are included in the aggregate cost reported in section V.E.

3. Operating Costs Associated With NO_X and PM Control

The Draft RIA assumes that a variety of new technologies will be introduced to enable heavy-duty vehicles to meet the new emissions standards we are proposing. Primary among these are advanced emission control technologies and low-sulfur diesel fuel. The many benefits of low-sulfur diesel fuel are described in section III, and the incremental cost for low-sulfur fuel is described in section V.D. The new emission control technologies are themselves not expected to introduce additional operating costs in the form of increased fuel consumption. Operating costs are estimated in the Draft RIA over the life of the vehicle and are expressed as a net present value (NPV) in 1999 dollars for comparison purposes.

Total operating cost estimates include both the expected increases in maintenance and fuel costs (both the incremental cost for low-sulfur fuel and any fuel consumption penalty) due to the emission control systems application and the predicted decreases in maintenance cost due to the use of low-sulfur fuel. Today's proposal estimates some increase in operating costs due to the incremental cost of low-sulfur diesel fuel but no net increase in fuel consumption with the application of the new emission control technologies (see discussion in section III.G). The net increase in operating costs are summarized in Table V.A–1. While we are using these incremental operating cost estimates for our cost effectiveness calculations, it is almost certain that the manufacturers will improve existing technologies or introduce new technologies in order to offset at least some of the increased operating costs. We request comment on these operating cost estimates and on ways in which industry may be able to offset these operating costs.

We estimate that the low-sulfur diesel fuel we are proposing to require in order to enable these technologies would have an incremental cost of approximately $0.044/gallon as discussed in section V.D. The proposed low-sulfur diesel fuel may also provide additional benefits by reducing the engine maintenance costs associated with corrosion due to sulfur in the current diesel fuel. These benefits, which are discussed further in section V.C and in the draft RIA, include extended oil

[138] Letter from Bruce Bertelsen, Manufacturers of Emission Controls Association (MECA) to William Charmley, US EPA, December 17, 1998. The letter documents a MECA member survey of expected diesel particulate filter costs. EPA Air Docket A–99–06.

change intervals due to the slower acidification rate of the engine oil with low-sulfur diesel fuel. Service intervals for the EGR system are also expected to increase due to lower-sulfur induced corrosion than will occur with today's higher-sulfur fuel. This lengthening of service intervals provides a significant savings to the end user. As described in more detail in the Draft RIA we anticipate that low-sulfur diesel fuel would provide additional cost savings to the consumer of $153 for light heavy-duty vehicles, $249 for medium heavy-duty vehicles and $610 for heavy heavy-duty vehicles. The operating costs for replacement filters in the closed crankcase filtration systems are estimated to be $48 for light heavy-duty vehicles, $72 for medium heavy-duty vehicles and $268 for heavy heavy-duty vehicles in 2007 and in the long term are expected to decrease to $31 for a light heavy-duty vehicle, $46 for a medium heavy-duty vehicle and $172 for a heavy heavy-duty vehicle. Factoring the cost savings due to low sulfur diesel fuel into the additional cost for low-sulfur diesel fuel and the service cost of the closed crankcase ventilation system yields a net increase in vehicle operating costs of $431 for a light heavy-duty vehicle, $826 for a medium heavy-duty vehicle and $3,362 for a heavy heavy-duty vehicle. These life cycle operating costs are also summarized in Table V.A–1. The net increase in operating cost can also be expressed as an average annual operating cost for each class of heavy-duty vehicle. Expressed as an approximate annual per vehicle cost, the additional operating cost is estimated as $50 for a light heavy-duty vehicle, $100 for a medium heavy-duty vehicle, and $400 for a heavy heavy-duty vehicle.

B. Cost for Gasoline Vehicles to Meet Proposed Emissions Standards

1. Summary of New System Costs

To perform a cost analysis for the proposed standards, we first determined a package of likely technologies that manufacturers could use to meet the proposed standards and then determined the costs of those technologies. In making our estimates we have relied on our own technology assessment which included publicly available information, such as that developed by California, as well as confidential information supplied by individual manufacturers, and the results of our own in-house testing.

In general, we expect that heavy-duty gasoline vehicles would (like Tier 2 light duty vehicles) be able to meet these standards through refinements of current emissions control components and systems rather than through the widespread use of new technology. More specifically, we anticipate a combination of technology upgrades such as the following:

- Improvements to the catalyst system design, structure, and formulation, plus an increase in average catalyst size and loading.
- Air and fuel system modifications including changes such as improved oxygen sensors, and calibration changes including improved precision fuel control and individual cylinder fuel control.
- Exhaust system modifications, possibly including air gapped components, insulation, leak free exhaust systems, and thin wall exhaust pipes.
- Increased use of fully electronic exhaust gas recirculation (EGR).
- Increased use of secondary air injection.
- Use of ignition spark retard on engine start-up to improve upon cold start emission control.
- Use of low permeability materials and minor improvements to designs, such as the use of low-loss connectors, in evaporative emission control systems.

We expect that the technologies needed to meet these proposed heavy-duty gasoline standards would be very similar to those required to meet the Tier 2 standards for vehicles over 8,500 pounds GVWR. Few heavy-duty gasoline vehicles currently rely on technologies such as close coupled catalysts and secondary air injection, but we expect they would do so to in order to meet the proposed 2007 standards.

For each group we developed estimates of both variable costs (for hardware and assembly time) and fixed costs (for R&D, retooling, and certification). Cost estimates based on the current projected costs for our estimated technology packages represent an expected incremental cost of vehicles in the near-term. For the longer term, we have identified factors that would cause cost impacts to decrease over time. First, since fixed costs are assumed to be recovered over a five-year period, these costs disappear from the analysis after the fifth model year of production. Second, the analysis incorporates the expectation that manufacturers and suppliers would apply ongoing research and manufacturing innovation to making emission controls more effective and less costly over time. Research in the costs of manufacturing has consistently shown that as manufacturers gain experience in production and use, they are able to apply innovations to simplify machining and assembly operations, use lower cost materials, and reduce the number or complexity of component parts.[139] These reductions in production costs are typically associated with every doubling of production volume. Our analysis incorporates the effects of this ''learning curve'' by projecting that a portion of the variable costs of producing the new vehicles decreases by 20 percent starting with the third year of production. We applied the learning curve reduction only once since, with existing technologies, there would be less opportunity for lowering production costs than would be the case with the adoption of new technology. We did not apply the learning curve reduction to precious metal costs, nor did we apply it for the evaporative standards. We invite comment on this methodology to account for the learning curve phenomena and also request comment on whether learning is likely to reduce costs in this industry.

We have prepared our cost estimates for meeting the new heavy-duty gasoline standards using a baseline of current technologies for heavy-duty gasoline vehicles and engines. Finally, we have incorporated what we believe to be a conservatively high level of R&D spending at $2,500,000 per engine where no California counterpart exists. We have included this large R&D effort because calibration and system optimization is likely to be a critical part of the effort to meet the standards. However, we believe that the R&D costs may be generous because the projection probably underestimates the carryover of knowledge from the development required to meet the light-duty Tier 2 and CARB LEV–II standards.

Table V.B–1 provides our estimates of the per vehicle increase in purchase price for heavy-duty gasoline vehicles and engines. The near-term cost estimates in Table V.B–1 are for the first years that vehicles meeting the standards are sold, prior to cost reductions due to lower productions costs and the retirement of fixed costs. The long-term projections take these cost reductions into account. We request comment on the costs shown in Table V.B–1 and the analysis behind them.

[139] See Chapter V of the final Tier 2 Regulatory Impact Analysis, contained in Air Docket A–97–10.

TABLE V.B–1.—PROJECTED INCREMENTAL SYSTEM COST AND LIFE CYCLE OPERATING COST FOR HEAVY-DUTY GASOLINE VEHICLES

[Net present values in the year of sale, 1999 dollars]

Vehicle class	Model year	Incremental system cost	Life-cycle operating cost
Heavy-Duty Gasoline	Near term	$182	$0
	Long term	152	0

2. Operating Costs Associated With Meeting the Heavy-Duty Gasoline Standard

Low sulfur gasoline is a fundamental enabling technology which will allows heavy-duty gasoline vehicles to meet the very low emission standards being proposed today. The low sulfur gasoline required under the Tier 2 proposal will enable advanced exhaust emission control for heavy-duty vehicles as well. Today's proposal puts no additional requirements on gasoline sulfur levels and as such should not directly increase gasoline fuel costs. Additionally, the new technologies being employed in order to meet the new standards are not expected to increase fuel consumption for heavy-duty gasoline vehicles. In fact, there may be some small improvement in fuel economy from the application of improved fuel and air control systems on these engines. Therefore, in the absence of changes to gasoline specifications and with no decrease in fuel economy, we do not expect any increase in vehicle operating costs.

C. Benefits of Low-Sulfur Diesel Fuel for the Existing Diesel Fleet

We estimate that the proposed low-sulfur diesel fuel would provide additional benefits to the existing heavy-duty vehicle fleet as soon as the fuel is introduced. We believe these benefits could offer significant cost savings to the vehicle owner without the need for purchasing any new technologies. The Draft RIA has catalogued a variety of benefits from the proposed low-sulfur diesel fuel. These benefits are summarized in Table V.C–1.

TABLE V.C–1.—COMPONENTS POTENTIALLY AFFECTED BY LOWER SULFUR LEVELS IN DIESEL FUEL

Affected components	Effect of lower sulfur	Potential impact on engine system
Piston Rings	Reduce corrosion wear	Extended engine life and less frequent rebuilds.
Cylinder Liners	Reduce corrosion wear	Extended engine life and less frequent rebuilds.
Oil Quality	Reduce deposits and less need for alkaline additives.	Reduce wear on piston ring and cylinder liner and less frequent oil changes.
Exhaust System (tailpipe)	Reduces corrosion wear	Less frequent part replacement.
EGR	Reduces corrosion wear	Less frequent part replacement.

The actual value of these benefits over the life of the vehicle would depend upon the length of time that the vehicle operates on low-sulfur diesel fuel and the degree to which vehicle operators change engine rebuild patterns to take advantage of these benefits. For a vehicle near the end of its life in 2007 the benefits would be quite small. However for vehicles produced in the years immediately preceding the introduction of low-sulfur fuel the savings would be substantial. The Draft RIA estimates that a heavy heavy-duty vehicle introduced into the fleet in 2006 would realize savings of $610 over its life. This savings could alternatively be expressed in terms of fuel costs as approximately 1 cent per gallon as discussed in the draft RIA. These savings would occur without additional new cost to the vehicle owner beyond the incremental cost of the low-sulfur diesel fuel, although these savings would require changes to existing maintenance schedules. Such changes seem likely given the magnitude of the savings and the nature of the regulated industry.

The maintenance benefits we project come primarily from extended oil change intervals. We have no quantitative data on how much longer these intervals might be. Based on discussions with some engine manufacturers, we believe it is reasonable to assume that engine oil change intervals will increase by 10 percent for each class of engine (in both new and existing fleets). We seek comment on this key assumption and on these projected savings and all of the assumptions behind them; details of the analysis behind these savings can be found in the draft RIA contained in the docket for this rule.

D. Cost of Proposed Fuel Change

We estimate that the overall cost associated with lowering the sulfur cap from the current level of 500 ppm to the 15 ppm level proposed today will be approximately 4.4 cents per gallon. As discussed in sections V.A. and V.C., this cost would be offset by a one cent per gallon savings (or more) from the reduction in vehicle maintenance savings that result from the use of the cleaner fuel. The fuel cost is comprised of a number of components associated with refining and distributing the fuel. The majority of the fuel cost is expected to be the refining cost which is estimated to be approximately 4.0 cents per gallon, which includes the cost of producing more volume of diesel fuel because desulfurization decreases the energy density of the fuel. The remaining 0.4 cents per gallon in fuel costs is associated with an anticipated increase in the use of additives to maintain fuel lubricity at a cost of 0.2 cents per gallon, and an increase in distribution costs of 0.2 cents per gallon. The increase in distribution costs comprises 0.1 cents per gallon to distribute the additional volume of diesel fuel needed to compensate for the decrease in fuel energy density, and 0.1 cents per gallon to maintain product integrity in the distribution system. These cost estimates are discussed in more detail below and in the Draft RIA.

When the 4.4 cent per gallon cost is applied to the expected low sulfur diesel fuel sales volume of approximately 40 billion gallons at the start of the program, it equates to an annual cost of roughly $1.8 billion per year. This fuel cost would be offset by a reduction in maintenance costs of roughly $0.4 billion per year.

1. Refinery Costs

As explained in Section IV, refiners would have to install capital equipment to meet the proposed diesel fuel sulfur standard. Presuming that refiners will want to minimize the cost involved and use conventional technology, refiners are expected to build onto their existing desulfurization unit by adding another hydrotreating reactor and other related equipment.

In our analysis, we estimated the cost of lowering onroad diesel fuel sulfur levels for a national average refinery starting from the current national average sulfur level of about 350 ppm down to 7 ppm. We believe that a refinery's average diesel fuel sulfur level would be roughly 7 ppm under a 15 ppm cap standard. We then calculated a national aggregate cost and cents-per-gallon cost. Based on this analysis we estimate that, on average, individual refiners in the years 2004–05 would be expected to invest about $30 million for capital equipment and spend about $8 million per year for each refinery to cover the operating costs associated with these desulfurization units. Since this average represents a diverse size range of refineries, some refineries would pay more and others less than this average cost. When the average per-refinery cost is aggregated for all the onroad diesel fuel expected to be produced in this country in 2007, we estimate that the total investment for desulfurizing diesel fuel would be about $1.9, $2.0, and $0.2 billion in 2004, 2005, and 2006, respectively, as discussed in section IV.B. Operating costs for these units are expected to be about $1.1 billion per year.

Using our estimated capital and operating costs we calculated the average per-gallon cost of reducing diesel fuel sulfur down to meet the proposed 15 ppm cap standard. Using a capital cost amortization factor based on a seven percent rate of return on investment before taxes, we estimated the average national cost for desulfurizing onroad diesel sulfur to be about 4.0 cents per gallon. This cost is our estimated cost to society of producing onroad diesel to meet a 15 ppm cap standard that we used for estimating cost effectiveness.

There is currently no commercial experience in the U.S. and only a limited amount of information in the public literature on the costs associated with reducing the sulfur level in diesel fuel to very low levels on an ongoing operational basis. Experience in Sweden involves other changes to the fuel as well that would tend to drive up the costs considerably. The EMA recently commissioned a study by Mathpro of the economics of controlling the sulfur content of highway and nonroad diesel fuel to various sulfur levels as low as 2 ppm. Unfortunately, none of the scenarios modeled in the EMA study are consistent with our proposal today. Furthermore, some of the assumptions made in the analysis are inconsistent with our standard assumptions for economic analysis. For example, Mathpro used a higher rate of return on new capital than the rate we use. Nevertheless, some insight can be gained from a broad comparison of Mathpro's and our cost projections. The proposed sulfur cap for highway diesel fuel is very roughly bracketed by two Mathpro sulfur control scenarios: (1) a highway diesel fuel standard of 20 ppm on average with a nonroad diesel fuel standard of 350 ppm on average, and (2) an highway diesel fuel standard of 2 ppm on average with a nonroad diesel fuel standard of 20 ppm on average. Mathpro's projected refining costs for these two scenarios range from 4 to just under 6 cents per gallon (citing their costs for revamping current diesel fuel hydrotreaters with reactors in series, which is equivalent to our technology projections). Considering that Mathpro uses a higher rate of return on capital and that both of their scenarios included controlling nonroad diesel fuel, the two sets of cost projections appear to be roughly consistent. This serves to give us some confidence that our cost estimate for a sulfur cap of 15 ppm on highway diesel fuel is reasonable. This is discussed in further detail in the Draft RIA.

Although API assisted in the study, API has expressed some concern about the accuracy of the EMA cost estimates. API highlighted their concerns on the EMA study in a memo to the Director the Office of Transportation Air Quality, which is included in the docket.[140] While API expressed their belief that the cost outcomes of the EMA study are, in general, reasonable, they expressed serious concerns about the cost of producing diesel with sulfur levels below 20 ppm (roughly equivalent to a 30 ppm cap). API believes that, particularly at extremely low sulfur levels, the measures needed to be taken would result in significantly higher costs than estimated by EMA. We request comment on this assessment.

We acknowledge that some refiners likely face higher desulfurization costs than others. This is generally the case with any fuel quality regulation, since the crude oils processed by, as well as the configurations and product slates of individual refineries vary dramatically. As mentioned in section IV, API believes that those refiners facing higher than average costs may decide to leave the highway diesel fuel market. They argue this is especially a possibility if they are faced with a sulfur standard below a 30 ppm average (or 50 ppm cap), which they believe will require very large investments for high pressure hydrotreating to maintain current highway diesel production volumes. API also believes that many refiners may reduce their production of highway diesel fuel, by switching the feedstocks (i.e., LCO) which are most difficult to desulfurize to other markets, thus avoiding the higher investments associated with high pressure hydrotreating. If some refiners reduce highway diesel fuel production, that could present an opportunity for other refiners, who choose to make the investment, of higher prices for the new 15 ppm sulfur product. Whether the potential for higher prices would be sufficient and be apparent with sufficient leadtime to allow refiners to make an added investment by the time the proposed rule is effective is currently unclear.

For example, the refining industry actually overbuilt desulfurization capacity for the current 500 ppm standard, as evidenced by the significant use in the off-highway market of diesel fuel produced to the current highway diesel sulfur standard of 500 ppm. Some of this overproduction may have been due to limitations in the distribution system to distribute both highway and off-highway grades of diesel fuel. Despite the overall market overproduction, a number of small refiners did decide to switch from the highway diesel fuel market to the off-highway diesel fuel market, presumably for economic reasons.

Another incentive for refiners to invest in highway diesel fuel desulfurization equipment is the potential for a growing light-duty diesel market. Many vehicle manufacturers have announced plans to equip their light-duty vehicles and, particularly, light-duty trucks with diesel engines. Refiners may want to ensure their

[140] Edward H. Murphy, API to Margo Oge, US EPA, October 26,1999.

presence in this growing and potentially profitable market.

Alternative markets for distillate products are limited in the U.S. The domestic off-highway diesel fuel and heating oil markets are much smaller than the highway diesel fuel market. The domestic off-highway diesel fuel and heating oil markets are currently in balance, considering the fact that some highway diesel fuel is currently being sold into these markets. Assuming that the distribution system can be changed to segregate highway and other distillate fuels more economically, some amount of current highway diesel fuel production could switch to these other markets with no loss of highway diesel fuel supply. In addition, although the off-highway diesel fuel market is growing, this growth will occur gradually over the next 6 years and not occur on April 1, 2006. The heating oil market is very seasonal (strong in the winter and weak in the summer), regional (strong in the Northeast) and not growing. Thus, overall, we do not see much opportunity for large domestic producers of highway diesel fuel to be able to shift their production to these other domestic markets.

Export opportunities for diesel fuel are also limited to some degree. Japan and Europe will have stringent sulfur caps in place by 2005 and have cetane requirements well beyond the cetane levels of current U.S. diesel fuel. Asia, while growing in demand for diesel fuel, has also been the focus of new grassroots refinery production and again has high cetane requirements. Thus, the primary areas for export of diesel fuel of average U.S. quality would appear to be Africa and Latin America.

Refiners have also raised the possibility of exporting some of their more difficult to desulfurize diesel feedstocks such as LCO to other distillate markets. While this may be a possibility to some degree as discussed in Section IV and the draft RIA, the opportunities to do so appear to be limited. We have not conducted a detailed analysis of the potential for this exportation. Refiners would have to hydrotreat this material to lower its sulfur content in order to meet the European Union 50 ppm sulfur cap (and increase its cetane) in order for it to be used as a diesel fuel blendstock. Otherwise, its only use without additional treating would be in heating fuel. With Europe and developing countries expected to experience increasing demand for non-diesel, distillate fuel, there may be economic opportunities for exporting such fuel.

We request comments on the possibility that the proposed sulfur cap would cause some refiners to abandon the U.S. highway diesel fuel market or to reduce highway diesel fuel production, as well as on the impact that this would have on diesel fuel supply and price in the U.S. We also request comment on whether refiners would likely desire to shift all their LCO to non-highway diesel fuel markets or just the heavier portion which contains the most sterically hindered compounds. We also request comment on the economic viability of alternative markets for current highway diesel fuel or its more difficult to desulfurize components. We also request comments on the ability of overseas refiners providing highway diesel fuel under the proposed sulfur cap should domestic refiners reduce production. Finally, as discussed in section VI.A., we are also considering various phase-in approaches for implementing the low sulfur diesel standard. A phase-in could help spread out the design, construction, and capital expenditure of refinery modifications necessary to comply with the proposed diesel fuel sulfur standard, and in so doing could further minimize any risk of supply shortages. We request comment on the appropriateness and ability of a phase-in to address these concerns.

2. Cost of Possibly Needed Lubricity Additives

As discussed in section IV, the refinery processes needed to achieve the sulfur standard have some potential to degrade the natural lubricity characteristics of the fuel. Consequently an increase in the use of lubricity additives for diesel fuel may be anticipated over the amounts used today. We contacted various producers of lubricity additives to get their estimates of what costs might be incurred for this increase in the use of lubricity additives. The cost estimates varied from 0.1 to 0.5 cents per gallon. This range is to be expected since the cost will be a strong function of not only the additive type, but also the assumed treatment rate and the volume of fuel that needs to be treated, both of which will be, to some extent, a function of the sulfur cap. As described in more detail in the Draft RIA, we have included in the fuel cost estimate an average cost of 0.2 cents per gallon for lubricity additives over the entire pool of low-sulfur highway diesel fuel. This estimate is comparable to an estimate made by Mathpro in a study sponsored by the EMA. We request comment on our cost estimate. In particular, we request comment on whether there may be unique costs for the military to maintain the lubricity of their distillate fuels. We request that such comments addressing this issue include a detailed discussion of the volumes of fuel effected, current lubricity additive use, and the additional measures that might be needed (and associated costs) to maintain the appropriate level of fuel lubricity.

3. Distribution Costs

Under the proposed 15 ppm sulfur cap, we project that distribution costs would increase by a total of 0.2 cents per gallon as discussed below.

If the proposed sulfur standard is adopted, there would be a greater difference between the sulfur content of highway diesel fuel and other distillate products than presently exists.[141] For example, off-highway diesel fuel currently has a sulfur content that is approximately ten times that of highway diesel. Under the proposed sulfur standard, off-highway diesel fuel would have a sulfur content over two hundred times that of highway diesel fuel. This could potentially make it more difficult to limit the sulfur contamination of highway diesel fuel with other distillate products as the fuel travels through the distribution system. As discussed in section IV, standard industry practices, if followed carefully, should be able to virtually eliminate the potential contamination. To do so, however, is expected to result in slightly increased costs in a few different parts of the distribution system.

We identified three segments in the distribution system (pipeline operators, terminal operators, and tank-truck operators) that might experience increased costs due to increased difficulty in limiting sulfur contamination under the proposed sulfur standard. As discussed in the Draft RIA, we estimate that the total increase in diesel distribution costs associated with adequately limiting sulfur contamination under today's proposal would be no more than 0.1 cents per gallon for the distribution system as a whole. The majority of this increased cost is attributed to the unavoidable mixing of highway diesel with other products that occurs in pipeline shipments. The amount of interface (e.g., mixture of a highway diesel batch and a nonroad diesel batch) that must be downgraded to a lower

[141] Highway diesel fuel currently must have a sulfur content of no more than 500 ppm and typically has an average sulfur content of 350 ppm. Off-highway diesel fuel sulfur content is currently unregulated and is approximately 3,500 ppm on average. The maximum allowed sulfur content of heating oil is 5,000 ppm. The maximum allowed sulfur content of kerosene (and jet fuel) is 3,000 ppm.

price product is expected to grow with a lower sulfur cap for highway diesel, resulting in a slightly increased cost for pipeline shipments. A slight increase in distribution costs is also expected to result at terminals due to the anticipated need for additional quality assurance testing at very low sulfur levels. We believe that, although tank-truck operators may need to more carefully observe current industry practices used to limit product contamination, this will not result in a significant increase in costs.

We invite comment on the amount of sulfur contamination which might be expected from each segment of the distribution system, the measures that might be taken to limit contamination, and the costs associated with these measures. We also request comment on the level of sulfur contamination in the distribution system that might be considered unavoidable without the imposition of an undue burden on diesel distributors and how this bears on the question of what sulfur level the refiner would need to meet at the refinery gate (the compliance margin) to ensure that highway diesel fuel does not exceed the proposed cap on sulfur content. Please refer to section IV.E for discussion of the compliance margin that we anticipate refiners will need to provide.

The energy density of diesel fuel would be decreased as a side effect of reducing sulfur content to the proposed 15 ppm cap. Consequently, to meet the same level of consumer demand an increased volume of diesel fuel would need to move through the distribution system. The cost of distributing this increased volume of diesel fuel was calculated within the model that used to evaluate refining costs (see the Draft RIA). Spread over the total volume of diesel fuel distributed, the additional cost is estimated at 0.1 cents per gallon. We request comment on this cost estimate.

E. Aggregate Costs

Using current data for the size and characteristics of the heavy-duty vehicle fleet and making projections for the future, the diesel per-engine, gasoline per-vehicle, and per-gallon fuel costs described above can be used to estimate the total cost to the nation for the emission standards in any year. Figure V.E–1 portrays the results of these projections.[142] All capital costs have been amortized.

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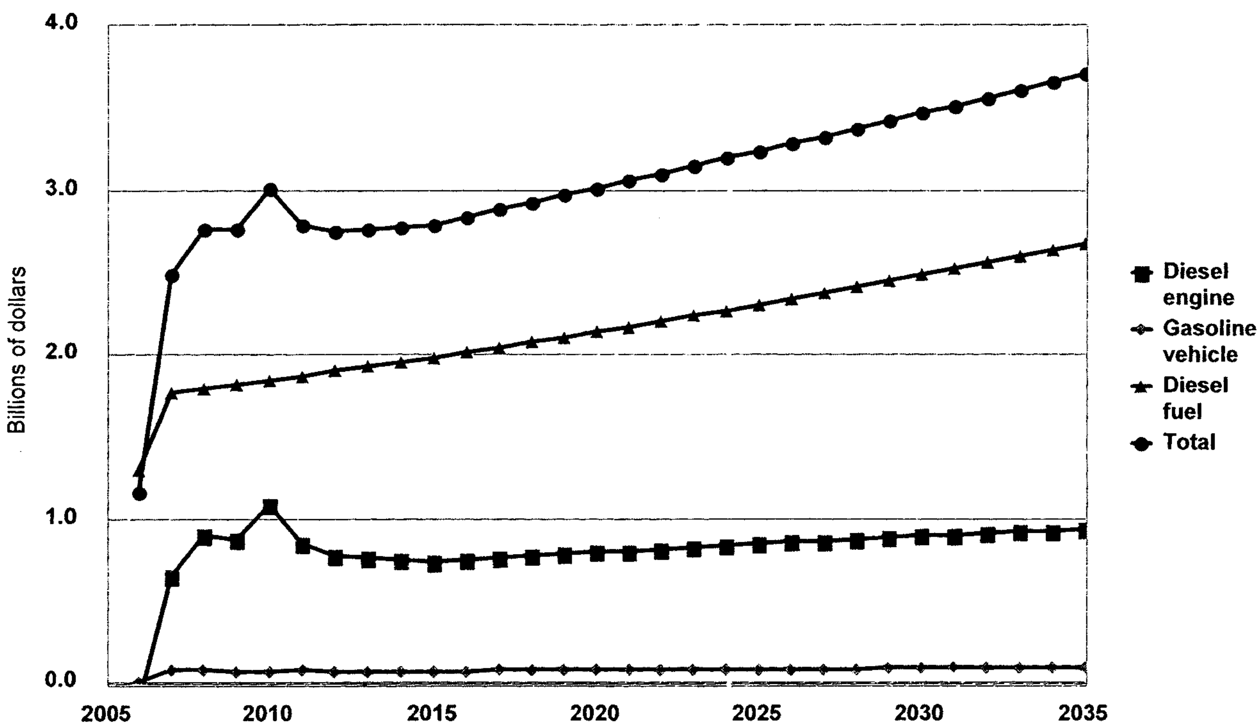
Figure V.E-1 Total Annualized Costs



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As can be seen from the figure, the annual costs start out at less than a billion dollars in year 2006 and increase over the phase-in period to about $2.8 billion in 2015. Thereafter, total annualized costs are projected to continue increasing due to the effects of projected growth in engine sales and fuel consumption. The Draft RIA provides further detail regarding these cost projections.

Future consumption of today's proposed low sulfur diesel fuel may be influenced by a potential influx of diesel-powered cars and light trucks into the light-duty fleet. At the present time, virtually all cars and light trucks being sold are gasoline fueled. However, the possibility exists that diesels will become more prevalent in the car and light-duty truck fleet, since automotive companies have announced their desire to increase their sales of diesel cars and light trucks. For the Tier 2 rulemaking, the Agency performed a sensitivity analysis using A.D.Little's ''most likely'' increased growth scenario of diesel penetration into the light-duty vehicle fleet which culminated in a 9 percent and 24 percent penetration of diesel vehicles in the LDV and LDT markets,

[142] Figure V.E–1 is based on the amortized engine, vehicle and fuel costs as described in the Draft RIA. Actual capital investments, particularly important for fuels, would occur prior to and during the initial years of the program.

respectively, in 2015 (see Tier 2 RIA, Table III.A. 13). Were this scenario to play out, the increased number of diesel-powered cars and light-duty trucks would increase the societal costs (those costs, in total, paid by consumers) for the proposed higher priced diesel fuel because more diesel fuel would be consumed. However, were more diesel vehicles to penetrate the light-duty fleet, less gasoline would be consumed than was estimated in our Tier 2 cost analysis. Also, diesel vehicles tend to get higher fuel economy. In the end, the effect of increased dieselization of the light-duty fleet may have little or no impact on the aggregate costs estimated for today's proposal. While we have not fully analyzed this light-duty diesel penetration scenario, we request comment on it and relevant data which would allow us to perform a sensitivity analysis.

F. Cost Effectiveness

One tool that can be used to assess the value of new standards for heavy-duty vehicles and engines is cost effectiveness, in which the costs incurred to reach the standards are compared to the mass of emission reductions. This analysis results in the calculation of a $/ton value, the purpose of which is to show that the reductions from the engine and fuel controls being proposed today are cost effective, in comparison to alternative means of control. This analysis involves a comparison of our program not only to past measures, but also to other potential future measures that could be implemented. Both EPA and states have already adopted numerous control measures, and remaining measures tend to be more expensive than those previously employed. As we and States tend to employ the most cost effective available measures first, more expensive ones must be adopted to achieve further emission reductions.

1. What Is the Cost Effectiveness of This Proposed Program?

We have calculated the cost-effectiveness of our proposed diesel engine/gasoline vehicle/diesel sulfur standards based on two different approaches. The first considers the net present value of all costs incurred and emission reductions generated over the life of a single vehicle meeting our proposed standards. This per-vehicle approach focuses on the cost-effectiveness of the program from the point of view of the vehicles and engines which will be used to meet the new requirements. However, the per-vehicle approach does not capture all of the costs or emission reductions from our proposed diesel engine/gasoline vehicle/diesel sulfur program since it does not account for the use of low sulfur diesel fuel in current diesel engines. Therefore, we have also calculated an 30-year net present value cost-effectiveness using the net present value of costs and emission reductions for all in-use vehicles over a 30-year time frame. The baseline or point of comparison for this evaluation is the previous set of engine, vehicle, and diesel sulfur standards (in other words, the applicable 2004 model year standards).

As described earlier in the discussion of the cost of this program, the cost of complying with the new standards will decline over time as manufacturing costs are reduced and amortized capital investments are recovered. To show the effect of declining cost in the per-vehicle cost-effectiveness analysis, we have developed both near term and long term cost-effectiveness values. More specifically, these correspond to vehicles sold in years one and six of the vehicle and fuel programs. Chapter VI of the RIA contains a full description of this analysis, and you should look in that document for more details of the results summarized here.

The 30-year net present value approach to calculating the cost-effectiveness of our program involves the net present value of all nationwide emission reductions and costs for a 30 year period beginning with the start of the diesel fuel sulfur program and introduction of model year 2007 vehicles and engines in year 2006. This 30-year timeframe captures both the early period of the program when very few vehicles that meet our proposed standards will be in the fleet, and the later period when essentially all vehicles in the fleet will meet our proposed standards. We have calculated the 30-year net present value cost-effectiveness using the net present value of the nationwide emission reductions and costs for each calender year. These emission reductions and costs are given for every calendar year in the RIA, in addition to details of the methodology we used to calculate the 30-year net present value cost-effectiveness.

Our per-vehicle and 30-year net present value cost-effectiveness values are given in Tables V.F–1 and V.F–2. Table V.F–1 summarizes the per-vehicle, net present value lifetime costs, NMHC + NO_X and PM emission reductions, and resulting cost-effectiveness results for our proposed diesel engine/gasoline vehicle/diesel sulfur standards using sales weighted averages of the costs (both near term and long term) and emission reductions of the various vehicle and engine classes affected. Table V.F–2 provides the same information from the program 30-year net present value perspective. It includes the net present value of the 30 year stream of vehicle and fuel costs, NMHC + NO_X and PM emission reductions, and the resulting 30-year net present value cost-effectiveness. Diesel fuel costs applicable to diesel engines have been divided equally between the adsorber and trap, since low sulfur diesel is intended to enable all technologies to meet our proposed standards. In addition, since the trap produces reductions in both PM and hydrocarbons, we have divided the total trap costs equally between compliance with the proposed PM standard and compliance with the proposed NMHC standard.

Tables V.F–1 and V.F–2 also display cost-effectiveness values based on two approaches to account for the reductions in SO_2 emissions associated with the reduction in diesel fuel sulfur. While these reductions are not central to the program and are therefore not displayed with their own cost-effectiveness, they do represent real emission reductions due to our program. The first set of cost-effectiveness numbers in the tables simply ignores these reductions and bases the cost-effectiveness on only the emission reductions from our proposed program. The second set accounts for these ancillary reductions by crediting some of the cost of the program to SO_2. The amount of cost allocated to SO_2 is based on the cost-effectiveness of SO_2 emission reductions that could be obtained from alternative, potential future EPA programs. The SO_2 credit was applied only to the PM calculation, since SO_2 reductions are primarily a means to reduce ambient PM concentrations.

TABLE V.F–1.—PER-ENGINE COST EFFECTIVENESS OF THE PROPOSED STANDARDS FOR 2007 AND LATER MY VEHICLES

Pollutants	Discounted lifetime vehicle & fuel costs	Discounted lifetime emission reductions (tons)	Discounted lifetime cost effectiveness per ton	Discounted lifetime cost effectiveness per ton with SO_2 credit[a]
Near-term costs[b]:				
NO_X+NMHC	$1535	0.8838	$1,736	$1,736
PM	872	0.0672	12,977	6,338
Long-term costs:				
NO_X+NMHC	1121	0.8838	1,268	1,268
PM	652	0.0672	9,704	3,065

[a] $446 credited to SO_2 (at $4800/ton) for PM cost effectiveness.
[b] As described above, per-engine cost effectiveness does not include any costs or benefits from the existing, pre-control, fleet of vehicles that would use the low sulfur diesel fuel proposed in this document.

TABLE V.F–2.—30-YEAR NET PRESENT VALUE[a] COST EFFECTIVENESS OF THE STANDARDS

	30-year n.p.v. engine, vehicle, & fuel costs (in billions)	30-year n.p.v. reduction (tons) (in millions)	30-year n.p.v. cost effectiveness per ton	30-year n.p.v. cost effectiveness per ton with SO_2 credit[b]
NO_X + NMHC	$28.9	18.9	$1,531	$1,531
PM	8.8	0.79	11,248	1,850

[a] This cost effectiveness methodology reflects the total fuel costs incurred in the early years of the program when the fleet is transitioning from pre-control to post-control diesel vehicles. In 2007 <10% of highway diesel fuel is anticipated to be consumed by 2007 MY vehicles. By 2012 this increases to >50% for 2007 and later MY vehicles.
[b] $7.4 billion credited to SO_2 (at $4800/ton).

2. Comparison With Other Means of Reducing Emissions

In comparison with other mobile source control programs, we believe that our program represents a cost effective strategy for generating substantial NO_X, NMHC, and PM reductions. This can be seen by comparing the cost effectiveness of today's program with a number of mobile source standards that EPA has adopted in the past. Table V.F–3 summarizes the cost effectiveness of several past EPA actions for NO_X+ NMHC. Table V.F–4 summarizes the cost effectiveness of several past EPA actions for PM.

TABLE V.F–3.—COST EFFECTIVENESS OF PREVIOUS MOBILE SOURCE PROGRAMS FOR NO_X+NMHC

Program	$/ton
Tier 2 vehicle/gasoline sulfur	1,311–2,211
2004 Highway HD diesel	207–405
Nonroad diesel engine	416–660
Tier 1 vehicle	2,010–2,732
NLEV	1,888
Marine SI engines	1,146–1,806
On-board diagnostics	2,263
Marine CI engines	23–172

Note.—costs adjusted to 1998 dollars.

TABLE V.F–4.—COST EFFECTIVENESS OF PREVIOUS MOBILE SOURCE PROGRAMS FOR PM

Program	$/ton
Marine CI engines	511–3,797
1996 urban bus	12,000–19,200
Urban bus retrofit/rebuild	29,600
1994 highway HD diesel	20,450–23,940

Note.—costs adjusted to 1998 dollars.

We can see from these tables that the cost effectiveness of our proposed diesel engine/gasoline vehicle/diesel sulfur standards falls within the range of these other programs for both NO_X+NMHC and PM. Our proposed program overlaps the range of the recently promulgated standards for Tier 2 light-duty vehicles and gasoline sulfur shown in Table V.F–3. Our proposed program also overlaps the cost-effectiveness of past programs for PM. It is true that some previous programs have been more cost efficient than the program we are proposing today. However, it should be expected that the next generation of standards will be more expensive than the last, since the least costly means for reducing emissions is generally pursued first.

In evaluating the cost effectiveness of our proposed diesel engine/gasoline vehicle/diesel sulfur program, we also considered whether our proposal is cost effective in comparison with possible stationary source controls. In the context of the Agency's rulemaking which would have revised the ozone and PM NAAQS,[143] the Agency compiled a list of additional known technologies that could be considered in devising new emission reductions strategies.[144] Through this broad review, over 50 technologies were identified that could reduce NOx, VOC, or PM. The cost effectiveness of these technologies averaged approximately $5,000/ton for VOC, $13,000/ton for NO_X, and $40,000/ton for PM. Although a $10,000/ton limit was actually used in the air quality analysis presented in the NAAQS revisions rule, these values clearly indicate that, not only are future emission control strategies likely to be more expensive (less cost effective) than past strategies, but the cost effectiveness of our proposed program falls well

[143] This rulemaking was remanded by the DC Circuit Court on May 14, 1999. However, the analyses completed in support of that rulemaking are still relevant, since they were designed to investigate the cost effectiveness of a wide variety of potential future emission control strategies.

[144] ''Regulatory Impact Analyses for the Particulate Matter and Ozone National Ambient Air Quality Standards and Proposed Regional Haze Rule,'' Appendix B, ''Summary of control measures in the PM, regional haze, and ozone partial attainment analyses,'' Innovative Strategies and Economics Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 17, 1997.

below the average of those choices, and is near the lower end of the range of potential future strategies.

In summary, we believe that the weight of the evidence from alternative means of providing substantial NO_X+NMHC and PM emission reductions indicates that our proposed diesel engine/gasoline vehicle/diesel sulfur program is cost effective. We believe this is true from the perspective of other mobile source control programs and from the perspective of other stationary source technologies that might be considered. We request comment on the cost-effectiveness of this program.

G. Does the Value of the Benefits Outweigh the Cost of the Proposed Standards?

In addition to cost-effectiveness, further insight regarding the merits of the standards can be provided by benefit-cost analysis. The purpose of this section is to propose the methods to be used in conducting an analysis of the economic benefits of the final rule for heavy-duty vehicles and diesel fuel, and to discuss the potential for economic benefits associated with the rule. While the quantification of the benefits will not be available until the final rule, it is our belief that, based on the similarity between today's proposed rule and Tier 2/gasoline sulfur rule in terms of the costs per ton of emissions reduced and types of health and welfare benefits expected, the health and welfare benefits would substantially outweigh the costs.

1. What Is the Purpose of This Benefit-Cost Comparison?

Benefit-cost analysis (BCA) is a useful tool for evaluating the economic merits of proposed changes in environmental programs and policies. In its traditional application, BCA estimates the economic ''efficiency'' of proposed changes in public policy by organizing the various expected consequences and representing those changes in terms of dollars. Expressing the effects of these policy changes in dollar terms provides a common basis for measuring and comparing these various effects. Because improvement in economic efficiency is typically defined to mean maximization of total wealth spread among all members of society, traditional BCA must be supplemented with other analyses in order to gain a full appreciation of the potential merits of new policies and programs. These other analyses may include such things as examinations of legal and institutional constraints and effects; engineering analyses of technology feasibility, performance and cost; or assessment of the air quality need.

In addition to the economic efficiency focus of most BCAs, the technique is also limited in its ability to project future economic consequences of alternative policies in a definitive way. Critical limitations on the availability, validity, or reliability of data; limitations in the scope and capabilities of environmental and economic effect models; and controversies and uncertainties surrounding key underlying scientific and economic literature all contribute to an inability to estimate the economic effects of environmental policy changes in exact and unambiguous terms. Under these circumstances, we consider it most appropriate to view BCA as a tool to inform, but not dictate, regulatory decisions such as the ones reflected in today's proposed rule.

Despite the limitations inherent in BCA of environmental programs, we consider it useful to analyze the potential benefits of today's proposed action both in terms of physical changes in human health and welfare and environmental change, and in terms of the estimated economic value of those physical changes.

2. What Is Our Overall Approach to the Benefit-Cost Analysis?

The basic question we will seek to answer in the BCA is: ''What are the net yearly economic benefits to society of the reduction in air pollutant emissions likely to be achieved by the proposed rule for heavy-duty vehicles and diesel fuel?'' In designing an analysis to answer this question, we will model the benefits in a future year (2030) that is representative of full-implementation of the program. We will also adopt an analytical structure and sequence similar to that of the benefit analysis for the Tier 2/gasoline sulfur rulemaking and used for the ''section 812 studies'' [145] to estimate the total benefits and costs of the entire Clean Air Act. Moreover, we will use many of the same models and assumptions actually used in the section 812 studies, and other Regulatory Impact Analyses (RIA's) prepared by the Office of Air and Radiation. By adopting the major design elements, models, and assumptions developed for the section 812 studies and other RIA's, we will largely rely on methods which have already received extensive review by the independent Science Advisory Board (SAB), by the public, and by other federal agencies. In addition to the 2030 analysis, we plan to provide further characterization of the benefits for the interim period between 2007 and 2030.

[145] The ''section 812 studies'' refers to (1) US EPA, Report to Congress: The Benefits and Costs of the Clean Air Act, 1970 to 1990, October 1997 (also known as the ''section 812 Retrospective); and (2) the first in the ongoing series of prospective studies estimating the total costs and benefits of the Clean Air Act (see EPA report number: EPA–410–R–99–001, November 1999).

3. What Are the Significant Limitations of the Benefit-Cost Analysis?

Every BCA examining the potential effects of a change in environmental protection requirements is limited to some extent by data gaps, limitations in model capabilities (such as geographic coverage), and uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. Deficiencies in the scientific literature often result in the inability to estimate changes in health and environmental effects, such as potential increases in premature mortality associated with increased exposure to carbon monoxide. Deficiencies in the economics literature often result in the inability to assign economic values even to those health and environmental outcomes which can be quantified, such as changes in visibility in residential areas. While these general uncertainties in the underlying scientific and economics literatures will be discussed in detail in the RIA for the final action, the key uncertainties are:

- The exclusion of potentially significant benefit categories (*e.g.,* health and ecological benefits of incidentally controlled hazardous air pollutants),
- Errors in measurement and projection for variables such as population growth,
- Variability in the estimated relationships of health and welfare effects to changes in pollutant concentrations.

In addition to these uncertainties and shortcomings which pervade all analyses of criteria air pollutant control programs, a number of limitations apply specifically to a BCA. Though we will use the best data and models available, we will likely be required to adopt a number of simplifying assumptions and to use data sets which, while reasonably close, will not match precisely the conditions and effects expected to result from implementation of the standards. For example, to estimate the effects of the program at full implementation we will need to project vehicle miles traveled and populations in the year 2030. These assumptions may play a significant role in determining the magnitude of the benefits estimate. In addition, the emissions data sets which will be used for the analysis may not anticipate the emissions reductions realized by other future actions and by expected near-future control programs. For example, it is possible that the proposed heavy-duty vehicle and diesel fuel sulfur standards will not be the governing vehicle emissions standards in 2030. In the years before 2030, the benefits from the proposed rule for heavy-duty vehicles and diesel fuel will be less than in 2030 because the heavy-duty fleet will not be fully phased in.

The key limitations and uncertainties unique to the BCA of the final rule, therefore, will include:

- Uncertainties in the estimation of future year emissions inventories and air quality,
- Uncertainties associated with the extrapolation of air quality monitoring data to some unmonitored areas required to better capture the effects of the standards on affected populations, and
- Uncertainties associated with the effect of potential future actions to limit emissions.

Despite these uncertainties, we believe the BCA will provide a reasonable indication of the expected economic benefits of the proposed rule for heavy-duty vehicles and diesel fuel in 2030 under one set of assumptions. This is because the analysis will focus on estimating the economic effects of the *changes* in air quality conditions expected to result from today's proposed action, rather than focusing on developing a precise prediction of the *absolute* levels of air quality likely to prevail in 2030. An analysis focusing on the changes in air quality can give useful insights into the likely economic effects of emission reductions of the magnitude expected to result from today's proposed rule.

4. How Will the Benefit-Cost Analysis Change From the Tier 2 Benefit-Cost Analysis?

We will evaluate the economics and scientific literature prior to conducting the benefit-cost analysis for the final rule. Our final benefit-cost methodology will reflect the most up to date set of health and welfare effects and the most current economic valuation methods. In addition, we will use updated emission inventories. We will also be evaluating the air quality models used to predict changes in future air quality for use in the benefits analysis.

5. How Will We Perform the Benefit-Cost Analysis?

The analytical sequence begins with a projection of the mix of technologies likely to be deployed to comply with the new standards, and the costs incurred and emissions reductions achieved by these changes in technology. The proposed rule for heavy-duty vehicles and diesel fuel has various cost and emission related components. These components would begin at various times and in some cases would phase in over time. This means that during the early years of the program there would not be a consistent match between cost and benefits. This is especially true for the vehicle control portions of the program, where the full vehicle cost would be incurred at the time of vehicle purchase, while the cost for low sulfur diesel fuel along with the emission reductions and benefits would occur throughout the lifetime of the vehicle.

To develop a benefit-cost number that is representative of a fleet of heavy-duty vehicles, we need to have a stable set of cost and emission reductions to use. This means using a future year where the fleet is fully turned over and there is a consistent annual cost and annual emission reduction. For the proposed rule for heavy-duty vehicles and diesel fuel, this stability would not occur until well into the future. For this analysis, we selected the year 2030. The resulting analysis will represent a snapshot of benefits and costs in a future year in which the heavy-duty fleet consists almost entirely of heavy-duty vehicles meeting the proposed standards. As such, it depicts the maximum emission reductions (and resultant benefits) and among the lowest costs that would be achieved in any one year by the program on a "per mile" basis. (Note, however, that net benefits would continue to grow over time beyond those resulting from this analysis, because of growth in population and vehicle miles traveled.) Thus, based on the long-term costs for a fully turned over fleet, the resulting benefit-cost ratio will be close to its maximum point (for those benefits which we have been able to value).

To present a BCA, we are designing the cost estimate to reflect conditions in the same year as the benefit valuation. Costs, therefore, will be developed for the year 2030 fleet. For this purpose we will use the long term cost once the capital costs have been recovered and the manufacturing learning curve reductions have been realized, since this will be the case in 2030.

We will also make adjustments in the costs to account for the fact that there is a time difference between when some of the costs are expended and when the benefits are realized. The vehicle costs are expended when the vehicle is sold, while the fuel related costs and the benefits are distributed over the life of the vehicle. We will resolve this difference by using costs distributed over time such that there is a constant cost per ton of emissions reduction and such that the net present value of these distributed costs corresponds to the net present value of the actual costs.

The resulting adjusted costs will be somewhat greater than the expected actual annual cost of the program, reflecting the time value adjustment. Thus, the costs will not represent expected actual annual costs for 2030. Rather, they will represent an approximation of the steady-state cost per ton that would likely prevail in that time period. The benefit cost ratio for the earlier years of the program would be expected to be lower than that based on these costs, since the per-vehicle costs are larger in the early years of the program while the benefits are smaller.

In order to estimate the changes in air quality conditions which would result from these emissions reductions, we will develop two separate, year 2030 emissions inventories to be used as inputs to the air quality models. The first, baseline inventory, will reflect the best available approximation of the county-by-county emissions for NO_X, VOC, and SO_2 expected to prevail in the year 2030 in the absence of the standards. To generate the second, control case inventory, we will first estimate the change in vehicle emissions, by pollutant and by county, expected to be achieved by the 2030 control scenario described above. We will then take the baseline emissions inventory and subtract the estimated reduction for each county-pollutant combination to generate the second, control case emissions inventory. Taken together, the two resulting emissions inventories will reflect two alternative states of the world and the differences between them will represent our best estimate of the reductions in emissions which would result from our control scenario.

With these two emissions inventories in hand, the next step will be to "map" the county-by-county and pollutant-by-pollutant emission estimates to the input grid cells of appropriately selected air quality and deposition models. One such model, called the Urban Airshed Model (UAM), is designed to estimate the tropospheric ozone concentrations resulting from a specific inventory of emissions of ozone precursor pollutants, particularly NO_X and NMHC. Another model, called the Climatological Regional Dispersion Model Source-Receptor Matrix model (S–R Matrix), is designed to estimate the changes in ambient particulate matter and visibility which would result from a specific set of changes in emissions of primary particulate matter and secondary particulate matter precursors, such as SO_2, NO_X, and NMHC. Also, nitrogen loadings to watersheds can be estimated using factors derived from previous modeling from the Regional Acid Deposition Model (RADM). By running both the baseline and control case emissions inventories through models such as these, we will be able to estimate the expected 2030 air quality conditions and the changes in air quality conditions which would result from the emissions reductions expected to be achieved by the proposed rule for heavy-duty vehicles and diesel fuel.

After developing these two sets of year 2030 air quality profiles, we will use the same health and environmental effect models used in the section 812 studies to calculate the differences in human health and environmental outcomes projected to occur with and without the proposed standards. Specifically, we will use the Criteria Air Pollutant Modeling System (CAPMS) to estimate changes in human health outcomes, and the Agricultural Simulation Model (AGSIM) to estimate changes in yields of a selected few agricultural crops. In addition, the impacts of reduced visibility impairment and estimates of the effect of changes in nitrogen deposition to a selection of sensitive estuaries will be estimated using slightly modified versions of the methods used in the section 812 studies. At proposal, we expect that several air quality-related health and environmental benefits, however, will not be able to be calculated for the BCA of today's proposed standards. Changes in human health and environmental effects due to changes in ambient concentrations of carbon monoxide (CO), gaseous sulfur dioxide (SO_2), gaseous nitrogen dioxide (NO_2), and hazardous air pollutants will likely not be included. In addition, some health and environmental benefits from changes in ozone and PM may not be included in our analysis (i.e., commercial forestry benefits). However, if our review of the economics and scientific literature reveals new information that will allow us to quantify these effects, they will be considered for inclusion in the estimate of total benefits for the final rule. Table IV–X lists the set of effects that we expect to be able to quantify for the BCA of the final rule, along with those effects which are known to exist, but that are currently unquantifiable.

To characterize the total economic value of the reductions in adverse effects achieved across the lower 48 states, we plan to use the same set of economic valuation coefficients and models used in the section 812 studies and the Tier 2 benefits analysis, as approved by the SAB. The set of coefficients and their sources are listed in the final Tier 2 RIA. However, any new methods uncovered in our evaluation of the economic and scientific literature may be incorporated into our final analysis. The net monetary benefits of the proposed rule for heavy-duty vehicles and diesel fuel will then be calculated by subtracting the estimated costs of compliance from the estimated monetary benefits of the reductions in adverse health and environmental effects.

The last step of the analysis will be to characterize the uncertainty surrounding our estimate of benefits. Again, we will follow the recommendations of the SAB for the presentation of uncertainty. They recommend that a primary estimate should be presented along with a description of the uncertainty associated with each endpoint.

Therefore, for the final rule for heavy-duty vehicles and diesel fuel, the benefit analysis will adopt an approach similar to the section 812 study and the final Tier 2/gasoline sulfur benefit-cost analysis. Our analysis will first present our estimate for a primary set of benefit endpoints followed by a presentation of ''alternative calculations'' of key health and welfare endpoints to characterize the uncertainty in this primary set. However, the adoption of a value for the projected reduction in the risk of premature mortality is the subject of continuing discussion within the economic and public policy analysis community within and outside the Administration. In response to the sensitivity on this issue, we will provide estimates reflecting two alternative approaches. The first approach—supported by some in the above community and preferred by EPA—uses a Value of a Statistical Life (VSL) approach developed for the Clean Air Act section 812 benefit-cost studies. This VSL estimate of $5.9 million (1997$) was derived from a set of 26 studies identified by EPA using criteria established in Viscusi (1992), as those most appropriate for environmental policy analysis applications.

TABLE V.G–1.—HUMAN HEALTH AND WELFARE EFFECTS OF POLLUTANTS AFFECTED BY THE PROPOSED HEAVY-DUTY VEHICLE RULE

Pollutant	Quantified and monetized effects	Alternative quantified and/or monetized effects	Unquantified effects
Ozone Health	Minor restricted activity days/acute respiratory symptoms; Hospital admissions—respiratory and cardio-vascular; Emergency room visits for asthma.		Premature mortality; [a] Increased airway responsiveness to stimuli; Inflammation in the lung; Chronic respiratory damage; Premature aging of the lungs; Acute inflammation and respiratory cell damage; Increased susceptibility to respiratory infection; Non-asthma respiratory emergency room visits.
Ozone Welfare	Decreased worker productivity; Decreased yields for commercial crops.		Decreased yields for commercial forests; Decreased yields for fruits and vegetables.
PM Health	Premature mortality; Bronchitis—chronic and acute; Hospital admissions—respiratory and cardio-vascular; Emergency room visits for asthma; Lower and upper respiratory illness; Shortness of breath; Minor restricted activity days/acute respiratory symptoms; Work loss days.		Infant mortality; Low birth weight; Changes in pulmonary function; Chronic respiratory diseases other than chronic bronchitis; Morphological changes; Altered host defense mechanisms; Cancer; Non-asthma respiratory emergency room visits.

TABLE V.G–1.—HUMAN HEALTH AND WELFARE EFFECTS OF POLLUTANTS AFFECTED BY THE PROPOSED HEAVY-DUTY VEHICLE RULE—Continued

Pollutant	Quantified and monetized effects	Alternative quantified and/or monetized effects	Unquantified effects
PM Welfare	Visibility in California, Southwestern, and Southeastern Class I areas.	Visibility in Northeastern, Northwestern, and Midwestern Class I areas; Household soiling.	
Nitrogen and Sulfate Deposition Welfare.		Costs of nitrogen controls to reduce eutrophication in selected eastern estuaries.	Impacts of acidic sulfate and nitrate deposition on commercial forests; Impacts of acidic deposition to commercial freshwater fishing; Impacts of acidic deposition in terrestrial ecosystems; Impacts of nitrogen deposition on commercial fishing, agriculture, and forests; Impacts of nitrogen deposition on recreation in estuarine ecosystems; Reduced existence values for currently healthy ecosystems.
CO Health			Premature mortality;[a] Behavioral effects; Hospital admissions—respiratory, cardiovascular, and other; Other cardiovascular effects; Developmental effects; Decreased time to onset of angina.
HAPS Health			Cancer (benzene, 1,3-butadiene, formaldehyde, acetaldehyde); Anemia (benzene); Disruption of production of blood components (benzene); Reduction in the number of blood platelets (benzene); Excessive bone marrow formation (benzene); Depression of lymphocyte counts (benzene); Reproductive and developmental effects (1,3-butadiene); Irritation of eyes and mucus membranes (formaldehyde); Respiratory irritation (formaldehyde); Asthma attacks in asthmatics (formaldehyde).
HAPS Welfare			Direct toxic effects to animals; Bioaccumlation in the food chain.

[a] Premature mortality associated with ozone is not separately included in this analysis. It is assumed that the Pope, et al. C–R function for premature mortality captures both PM mortality benefits and any mortality benefits associated with other air pollutants.

An alternative, age-adjusted approach is preferred by some others in the above community both within and outside the Administration. This approach was also developed for the Section 812 studies and addresses concerns with applying the VSL estimate—reflecting a valuation derived mostly from labor market studies involving healthy working-age manual laborers—to PM-related mortality risks that are primarily associated with older populations and those with impaired health status. This alternative approach leads to an estimate of the value of a statistical life year (VSLY), which is derived directly from the VSL estimate. It differs only in incorporating an explicit assumption about the number of life years saved and an implicit assumption that the valuation of each life year is not affected by age.[146] The mean VSLY is $360,000 (1997$); combining this number with a mean life expectancy of 14 years yields an age-adjusted VSL of $3.6 million (1997$).

Both approaches are imperfect, and raise difficult methodological issues which are discussed in depth in the recently published Section 812 Prospective Study, the draft EPA Economic Guidelines, and the peer-review commentaries prepared in support of each of these documents. For example, both methodologies embed assumptions (explicit or implicit) about which there is little or no definitive scientific guidance. In particular, both methods adopt the assumption that the risk versus dollars trade-offs revealed by available labor market studies are applicable to the risk versus dollar trade-offs in an air pollution context.

EPA currently prefers the VSL approach because, essentially, the method reflects the direct application of what EPA considers to be the most reliable estimates for valuation of premature mortality available in the current economic literature. While there are several differences between the labor market studies EPA uses to derive a VSL estimate and the particulate matter air pollution context addressed here, those differences in the affected populations and the nature of the risks imply both upward and downward adjustments. For example, adjusting for age differences may imply the need to adjust the $5.9 million VSL downward as would adjusting for health differences, but the involuntary nature of air pollution-related risks and the lower level of risk-aversion of the

[146] Specifically, the VSLY estimate is calculated by amortizing the $5.9 million mean VSL estimate over the 35 years of life expectancy asssociated with subjects in the labor market studies. The resulting estimate, using a 5 percent discount rate, is $360,000 per life-year saved in 1997 dollars. This annual average value of a life-year is then multiplied times the number of years of remaining life expectancy for the affected population (in the case of PM-related premature mortality, the average number of $ life-years saved is 14).

manual laborers in the labor market studies may imply the need for upward adjustments. In the absence of a comprehensive and balanced set of adjustment factors, EPA believes it is reasonable to continue to use the $5.9 million value while acknowledging the significant limitations and uncertainties in the available literature. Furthermore, EPA prefers not to draw distinctions in the monetary value assigned to the lives saved even if they differ in age, health status, socioeconomic status, gender or other characteristic of the adult population.

Those who favor the alternative, age-adjusted approach (i.e. the VSLY approach) emphasize that the value of a statistical life is not a single number relevant for all situations. Indeed, the VSL estimate of $5.9 million (1997 dollars) is itself the central tendency of a number of estimates of the VSL for some rather narrowly defined populations. When there are significant differences between the population affected by a particular health risk and the populations used in the labor market studies—as is the case here—they prefer to adjust the VSL estimate to reflect those differences. While acknowledging that the VSLY approach provides an admittedly crude adjustment (for age though not for other possible differences between the populations), they point out that it has the advantage of yielding an estimate that is not presumptively biased. Proponents of adjusting for age differences using the VSLY approach fully concur that enormous uncertainty remains on both sides of this estimate—upwards as well as downwards—and that the populations differ in ways other than age (and therefore life expectancy). But rather than waiting for all relevant questions to be answered, they prefer a process of refining estimates by incorporating new information and evidence as it becomes available.

The presentation of the alternative calculations for certain endpoints will demonstrate how much the overall benefit estimate might vary based on the value EPA gives to a parameter (which has some uncertainty associated with it) underlying the estimates for human health and environmental effect incidence and the economic valuation of those effects. These alternative calculations will represent conditions that are possible to occur, however, EPA has selected the best supported values based on current scientific literature for use in the primary estimate. The alternate calculations will include:

- Presentation of an estimated confidence interval around the Primary estimate of benefits to characterize the standard error in the C–R and valuation studies used in developing benefit estimates for each endpoint;
- Valuing PM-related premature mortality based on a different C–R study;
- Value of avoided premature mortality incidences based on statistical life years;
- Consideration of reversals in chronic bronchitis treated as lowest severity cases;
- Value of visibility changes in all Class I areas;
- Value of visibility changes in Eastern U.S. residential areas;
- Value of visibility changes in Western U.S. residential areas;
- Value of reduced household soiling damage; and
- Avoided costs of reducing nitrogen loadings in east coast estuaries.

For instance, the estimate of the relationship between PM exposure and premature mortality from the study by Dockery, et al. is a plausible alternative to the Pope, et al. study used for the Primary estimate of benefits. The SAB has noted that ‘‘the study had better monitoring with less measurement error than did most other studies’’ (EPA–SAB–COUNCIL–ADV–99–012, 1999). The Dockery study had a more limited geographic scope (and a smaller study population) than the Pope, et al. study and the Pope study appears more likely to mitigate a key source of potential confounding. The Dockery study also covered a broader age category (25 and older compared to 30 and older in the Pope study) and followed the cohort for a longer period (15 years compared to 8 years in the Pope study). For these reasons, the Dockery study is considered to be a plausible alternative estimate of the avoided premature mortality incidences that are expected to be associated with the final heavy-duty rule rule. The alternative estimate for mortality can be substituted for the valuation component in our primary estimate of mortality benefits to observe how the net benefits of the program may be influenced by this assumption. Unfortunately, it is not possible to combine all of the assumptions used in the alternate calculations to arrive at different total benefit estimates because it is highly unlikely that the selected combination of alternative values would all occur simultaneously. Therefore, it will be more appropriate to consider each alternative calculation individually to assess the uncertainty in the estimate.

In addition to the estimate for the primary set of endpoints and alternative calculations of benefits, our RIA for the final rule will also present an appendix with supplemental benefit estimates and sensitivity analyses of other key parameters in the benefit analysis that have greater uncertainty surrounding them due to limitations in the scientific literature. Supplemental estimates will be presented for premature mortality associated with short-term exposures to PM and ozone, asthma attacks, occurrences of moderate or worse asthma symptoms, and the avoided incidences of premature mortality in infants.

Even with our efforts to fully disclose the uncertainty in our estimate, this uncertainty presentation method does not provide a definitive or complete picture of the true range of monetized benefits estimates. This proposed approach, to be implemented in the BCA for the final rule, will not reflect important uncertainties in earlier steps of the analysis, including estimation of compliance technologies and strategies, emissions reductions and costs associated with those technologies and strategies, and air quality and deposition changes achieved by those emissions reductions. Nor does this approach provide a full accounting of all potential benefits associated with the proposed rule for heavy-duty vehicles and diesel fuel, due to data or methodological limitations. Therefore, the uncertainty range will only be representative of those benefits that we will be able to quantify and monetize.

6. What Types of Results Will Be Presented in the Benefit-Cost Analysis?

The BCA for the final rule for heavy-duty vehicles and diesel fuel will reflect a single year ‘‘snapshot’’ of the yearly benefits and costs expected to be realized once the standards have been fully implemented and non-compliant vehicles have all been retired. Near-term costs will be higher than long-run costs as vehicle manufacturers and oil companies invest in new capital equipment and develop and implement new technologies. In addition, near-term benefits will be lower than long-run benefits because it will take a number of years for compliant heavy-duty vehicles to fully displace older, more polluting vehicles. However, we will adjust the cost estimates upward to compensate for some of this discrepancy in the timing of benefits and costs and to ensure that the long-term benefits and costs are calculated on a consistent basis. Because of the adjustment process, the cost estimates should not be interpreted as reflecting the actual costs expected to be incurred in the year 2030. Actual program costs can be found earlier in this preamble.

With respect to the benefits, the BCA for the final rule for heavy-duty vehicles and diesel fuel will follow the presentation format used in the Tier 2 BCA, presenting several different measures of benefits which will be useful to compare and contrast to the estimated compliance costs. These benefit measures include (a) the tons of emissions reductions achieved, (b) the reductions in incidences of adverse health and environmental effects, and (c) the estimated economic value of those reduced adverse effects. Calculating the cost per ton of pollutant reduced is particularly useful for comparing the cost-effectiveness of the new standards or programs against existing programs or alternative new programs achieving reductions in the same pollutant or combination of pollutants. Considering the absolute numbers of avoided adverse health and environmental effects can also provide valuable insights into the nature of the health and environmental problem being addressed by the proposed rule as well as the magnitude of the total public health and environmental gains potentially achieved. Finally, when considered along with other important economic dimensions—including environmental justice, small business financial effects, and other outcomes related to the distribution of benefits and costs among particular groups—the direct comparison of quantified economic benefits and economic costs can provide useful insights into the potential magnitude of the estimated net economic effect of the rule, keeping in mind the limited set of effects we expect to be able to monetize.

VI. Alternative Program Options

In the course of developing the proposal, we considered a broad range of options, many of which were raised by commenters on the ANPRM. Various options were considered for the best manner to implement a change to diesel fuel, on how to structure a sulfur standard, on fuel changes other than sulfur, and on the geographic scope of the program. This section helps to explain many alternative program options that we considered in designing today's proposal. In this section, we also are seeking comment on voluntary phase-in options for implementing the fuel program (see section VI.A.2), and on issues connected with the use of JP–8 fuel in highway-going military vehicles (see section VI.D).

A. What Other Fuel Implementation Options Have We Considered?

A broad spectrum of approaches for implementing the fuel program were either raised by the Agency in the ANPRM, received as public comments on the ANPRM, or raised by various parties during the development of this proposal. Below, we discuss some of the options we have considered, including alternatives on which we are seeking comment.

1. What Are the Advantages and Disadvantages of a Phase-in Approach to Implementing the Low Sulfur Fuel Program?

EPA is proposing, as discussed in section IV.C., that the entire pool of highway diesel fuel be converted to low sulfur diesel fuel all at once in 2006. In the early years of the program, the use of low sulfur diesel fuel will result in reductions in the amount of direct and secondary particulate matter from the existing fleet of heavy-duty vehicles. Nevertheless, the primary benefit of the fuel change is the emission reductions that would occur over time from the new vehicle fleet as a result of the enablement of advanced aftertreatment exhaust emission control technologies. Consequently, we believe there may be some advantages, particularly in the early years, to allowing some flexibility in the program so that not all of the highway diesel fuel pool must be converted to low sulfur all at once. First, owners of old vehicles could continue to refuel on higher-sulfur (500 ppm) diesel fuel, potentially saving money for consumers. Second, we believe a phase-in approach, if designed properly, has the potential to be beneficial for refiners, by reducing the fuel production costs in the early years of the program. This flexibility could reduce operating costs, if the entire volume of highway fuel does not have to meet the low sulfur standard. If coupled with averaging, banking and trading provisions, some refineries may be able to delay desulfurization investments for several years. Even for refiners planning to desulfurize their entire highway fuel pool to low sulfur levels at the beginning of the program, there may be circumstances where the actual fuel produced is slightly off-spec (i.e., above the low sulfur standard). A phase-in approach could allow refiners to continue selling that fuel to the highway market (as 500 ppm fuel), rather than to other distillate markets. Refiners could also have more flexibility to continue producing highway diesel (as 500 ppm fuel) during unit downtime (e.g., turnarounds and upsets).

While a phase-in approach could provide flexibility for refiners and potentially lower costs for consumers, a number of concerns would need to be addressed before such an approach could be implemented. These include: ensuring sufficient availability of the low sulfur fuel when and where it is needed, minimizing the potential for misfueling, minimizing the risk of spot outages, and minimizing impacts on the fuel distribution and retail industries. These issues are discussed further below. It is not obvious at what level the fuel production and distribution systems can provide two grades of highway diesel fuel while minimizing the potential for localized supply shortages and price spikes, and misfueling problems. For example, we expect that in the first year of the program only about 10 percent of highway diesel fuel would be consumed by 2007 model year vehicles requiring the use of low sulfur fuel. In a perfect world where the distribution system could, without additional cost, make low sulfur diesel fuel widely available (in addition to the current 500 ppm fuel), only about 10 percent of the highway diesel fuel produced by refiners in the first year would then have to be low sulfur. Unfortunately, since this perfect world does not exist, the question remains whether, and to what extent, the system can distribute two grades of highway diesel fuel in a way that takes advantage of any flexibilities offered, and ensures sufficient supply of fuel for the new vehicles that need it.

During the process of developing this proposal (including comments received on the ANPRM), many industry stakeholders (many diesel distributors, marketers, larger refiners, and end-users such as truckers and centrally-fueled fleets) have commented on ways to implement the fuel program. While each stakeholder may have had different assumptions behind their position (including assumptions about the structure of a phase-in, and expectations about the resulting costs and fuel prices), many stakeholders have encouraged EPA to implement any fuel change all at once, rather than incur the added distribution costs and marketplace complication of phasing in a new grade of highway diesel fuel. The following sections discuss some of the challenges in implementing a phase-in approach.

a. Availability of Low Sulfur Diesel Fuel

Because new vehicles would need to be fueled exclusively with low sulfur diesel, for a phase-in approach to be workable, low sulfur diesel fuel would have to be available in all parts of the country. It is not clear what minimum level of availability would be necessary to meet the needs of diesel vehicles. The trucking industry has indicated that a limited number of phased-in fueling locations would not meet the needs of the trucking industry.

We seek comment on what level of availability would be appropriate under a phase-in approach, to ensure that the low sulfur diesel fuel is available, within a reasonable distance, to all consumers in all parts of the country. For example, would sufficient availability be achieved if all major truck stops across the country offered low sulfur fuel, or if some minimum percentage of diesel retailers in different geographic areas offered low sulfur fuel? Are there studies on fuel availability that would serve to inform efforts to assure adequate availability? We request that commenters consider what fraction of truck stops and other retail outlets would need to make low sulfur fuel available within any given area in order to ensure reasonable availability from the public's perspective.

b. Misfueling

Any phase-in approach would introduce an additional grade of highway diesel fuel into the market, by allowing both high and low-sulfur grades to coexist, with a potential for a price differential between the grades. Many industry stakeholders, including diesel marketers, truck stop operators, and engine manufacturers, have commented that misfueling would be significant under a phase-in approach.[147] That is, customers with new vehicles that need low-sulfur fuel might use the higher-sulfur fuel, mistakenly or deliberately, which could increase emissions and damage the emissions control technology on the vehicle. Diesel marketers have also raised the issue that a phase-in system could create incentives for consumers to tamper with the emission control equipment of new vehicles, if they believe that will enable them to use a lower priced fuel. Therefore, we are concerned about the potential for misfueling, as it could reduce the emission benefits of the program. However, if a phase-in approach were to work well and misfueling were not an issue, we would expect to achieve the same environmental benefits as the proposed single fuel approach.

Some degree of misfueling occurs even today with a single grade of highway diesel fuel, due to the availability of tax exempt off-highway diesel fuel. The opportunity for misfueling with off-highway diesel fuel, however, is somewhat limited by the limited number of highway diesel refueling locations that market both grades of diesel fuel. Nevertheless, since off-highway diesel fuel will still be available even under a complete switch of highway diesel fuel to low sulfur, the problem of misfueling is not entirely unique to the phase-in approach. It is, however, true that the greater availability of 500 ppm diesel fuel alongside the low sulfur fuel will make misfueling easier. Thus, the appropriate question to ask when considering a phase-in approach is not ''will people misfuel?'' but ''to what extent?'' and ''how can the design of the program minimize the potential for misfueling?''

One factor that might encourage misfueling would be the existence of a price differential between low sulfur diesel fuel and 500 ppm fuel. For many diesel vehicles, particularly line-haul tractor trailers, the fuel cost can be as much as 20 percent of annual operating costs, so drivers have a strong incentive to save on fuel costs. On the other hand, there are also several factors that might serve as a deterrent to misfueling. First, the potential risk associated with voiding a manufacturer emission warranty or damaging the engine and exhaust system on an expensive vehicle might cause owners and operators of heavy-duty trucks to be more circumspect in ensuring that their vehicles are fueled properly. Second, misfueled vehicles could experience a loss in performance, such as poor acceleration or even engine stalling (as discussed in section III.F.1.a). Third, under the proposed regulations it would be unlawful for any person to misfuel.

Depending on the potential for misfueling, EPA may need to require that new vehicles be fitted with a unique nozzle interface, with a corresponding size nozzle for the low-sulfur diesel. This would be analogous to the nozzle interface approach used to discourage misfueling in the unleaded gasoline program. However, diesel marketers have indicated that they do not support the use of unique nozzle interfaces for the low sulfur fuel, particularly if it would affect volume delivery. They have expressed the concern that a smaller nozzle size would reduce the volume of fuel delivered, result in slower refuelings, and increase wait times at retail stations. Further, based on our experience with unleaded gasoline,[148] it is likely that people intent on misfueling would quickly find ways around a unique nozzle/nozzle interface. We request comment on ways to structure a unique nozzle/nozzle interface approach that would discourage misfueling while avoiding these problems. We also request comment on any alternative methods that could be used to discourage misfueling.

We invite comment on the potential for misfueling under phase-in approaches, what factors would influence misfueling, and how the potential for misfueling might vary under the different phase-in approaches described in subsection 2 below. We further seek comment on how these phase-in approaches could be designed to minimize the potential for misfueling.

c. Distribution System Impacts

While providing flexibility for refiners and potentially lower costs to consumers, a phase-in approach would rely on the fuel distribution infrastructure being able to accommodate the second grade of highway diesel fuel. The economics of modifying the distribution infrastructure to handle two grades of highway diesel fuel would affect the extent to which refiners can take advantage of the flexibility, and consumers enjoy the cost-savings, of a phase-in. There are a vast array of businesses in the diesel fuel distribution system, encompassing thousands of companies, including pipelines, bulk terminals, bulk plants, petroleum marketers (who carry the fuel from bulk terminals and bulk plants via transport trucks and fuel tank wagons to retail outlets and fleet customers), fuel oil dealers, service stations, truck stops, and centrally-fueled fleets (commercial fleets, federal/state/local government fleets, and farms). Based on available data, the vast majority of these are small businesses according to the Small Business Administration's definitions.[149] These businesses may make investments and change their practices to accommodate two grades of highway diesel fuel. The economics of a phase-in could be viewed as follows: Through intermediate price mark-ups on the product, the system would distribute some of the cost savings experienced by the refiners and consumers to those making capital investments. If the potential cost savings

[147] Comment letters from the Engine Manufacturers Association (Item II–D–35), National Association of Truck Stop Operators (Included in Report of the Small Business Advocacy Review (SBAR) Panel, Appendix B, Page 30), and Petroleum Marketers Association of America (Included in SBAR Panel Report, Appendix B, Page 38).

[148] ''An Analysis of the Factors Leading to the Use of Leading to the Use of Leaded Gasoline in Automobiles Requiring Unleaded Gasoline,'' September 29, 1978, Sobotka & Company, Inc. See also ''Motor Vehicle Tampering Survey—1983,'' July 1984, U.S. EPA, Office of Air and Radiation, Docket A–99–06. See also ''Anti-Tampering and Anti-Misfueling Programs to Reduce In-Use Emissions From Motor Vehicles,'' May 25, 1983 (EPA/AA/83–3). Contained in Docket A–99–06.

[149] For more information, see the Report of the Small Business Advocacy Review Panel, contained in the docket.

were not sufficient to justify such investments, then those investments would not occur and the entire system would convert to low sulfur diesel. We seek comment on how the economics of a phase-in would actually play out.

If the cost savings of a phase-in are substantial, many bulk terminals and bulk plants may find it economical to add new tank capacity to accommodate a second grade of highway diesel fuel. However, if the cost savings of a phase-in are modest, fewer terminal operators would profit from such investments, since some have commented on the costs, space constraints, and permitting difficulties associated with new tankage.[150] The magnitude of the cost savings also affects the role of diesel marketers in this market. Some marketers have commented that if some terminals offer two grades while others offer only one grade, the costs of transporting fuel would increase since some trucks would have to travel greater distances to alternate terminals or bulk plants.[151] The share of the cost savings that marketers could enjoy from the mark-up on diesel products would have to at least equal the higher transport costs for them to offer to handle two grades of fuel.

Similarly, many service stations, truck stops, and centrally-fueled fleets would be faced with a decision of whether to add additional underground storage tanks to carry the extra grade of diesel fuel. Retailers with more than one diesel tank, such as many truck stops and some fleets, could choose to demanifold existing tanks (involving breaking concrete) in order to dedicate one or more tanks to the new fuel. Those that find it economical to do so will undertake the investment and offer two grades, while those that would not find the investment profitable would forego this option.

Generally we would expect that where businesses could profit from managing two grades they would do so and provide some 500 ppm diesel to the market. Thus, the impact to the distribution system of a phase-in would include costs from new investments, but these could be compensated by higher profits. Where the costs of handling two fuels in the distribution system are larger than the cost savings enjoyed by refineries (and passed down to consumers in lower fuel prices), then only low sulfur diesel would be offered. Some refiners and distributors have expressed the concern, however, that these additional investments would be ''stranded'' after the phase-in period ends. A key question will be whether each party in the refining/distribution system can accurately anticipate what the others will do, so as to avoid unnecessary investments (e.g., if the system should switch over the low sulfur more quickly than expected). Since the diesel fleet transitions over relatively quickly (greater than 50 percent of VMT is typically driven by new diesel vehicles after just 5 years), there may be limited time to recoup any investment made to handle an additional grade of highway diesel fuel. We request comment overall on the economics of a phase-in approach.

In addition to overall impacts on the distribution system, an additional grade of highway diesel fuel could reduce the flexibility of the distribution system to carry all grades of fuels that it does today. This may particularly be a concern with specialty fuels or segregated shipments of fuel through pipelines that require separate tankage such as those utilized by the Department of Defense (DOD). DOD stated that since its specialty fuels (F–76, JP–5, and JP–8) are not fungible fuels, if today's rule places additional stress on an already capacity-strained pipeline system, it may limit DOD's ability to transport adequate volumes of their specialty fuels to meet operational readiness requirements. Consequently we request comment on this particular impact on the distribution system in regard to accommodating a second grade of highway diesel fuel.

d. Uncertainty in the Transition to Low Sulfur

We believe the proposed single fuel approach provides more certainty to the market for making the large investments needed to introduce low-sulfur fuel. Yet even under a single fuel approach, refiners have indicated that there is uncertainty in refiner decisions to invest or not (or to underinvest) in desulfurization, which could lead to a risk of supply shortfalls and high prices. Refiners may make this choice to exit the highway diesel market, or to reduce production volume of highway diesel fuel, especially if faced with uncertainty about the ability to recover their investments (see further discussion in section V.D.1). A phase-in approach could minimize any potential for such a shortfall in the overall highway diesel fuel supply. Under a phase-in, the level of uncertainty is different, however, in that since the highway diesel pool would be split into two grades, refiners would need to predict in advance the relative demand for each grade.

Under the phase-in flexibility approaches (described in the following section), the presumption is that the fuel production and distribution system will react to both the market demand and the incentive of the various programs to produce and distribute the low sulfur fuel at reasonable prices to all parts of the country. Turning any of these approaches into a reality requires embracing the possibility that the market reacts differently than anticipated. For example, diesel retailers have indicated that it would be extremely difficult to predict how retailers would respond to making low sulfur fuel available, given the many factors that influence retail decisions. Consequently, refiners might have little certainty about continued markets for 500 ppm fuel when making their investment decisions and all of them might choose to convert to low sulfur. Given the lead time needed for additional desulfurization capacity at refineries to come on line, it is important for a smooth transition to low sulfur diesel fuel that predictions of demand be similar to the actual demand. Each of the phase-in approaches described in the following section is intended to be designed to allow the market the flexibility to find a lower cost option than full initial conversion to low sulfur fuel if such a solution exists, and to default to a full low sulfur program if such a solution does not exist. Each approach is, however, subject to different sources of uncertainty. We request comment on the ability of refiners to accurately predict demand for desulfurization capacity under a phase-in approach. Commenters should discuss this issue in the context of the phase-in approaches described below and in the context of the proposed single fuel approach.

e. Cost Considerations Under a Phase-in Approach

Because it avoids the need to produce all of the fuel to the low sulfur standard in the first year, a phase-in approach could provide an opportunity for cost savings to refiners and could significantly lower overall diesel fuel production costs. Consumers of pre-2007 diesel vehicles could also realize a savings if the current 500 ppm fuel were still available and priced lower than the new low sulfur fuel. In a perfect world with a distribution system capable of distributing a second grade of highway diesel fuel at no cost, if low sulfur production could be matched with the demand from new vehicles, the fraction of highway diesel fuel that would have to be low sulfur would increase from approximately 9% in

[150] Letter from Independent Terminal Operators Association, July 13, 1999 (Item # II–D–80).

[151] Letter from Petroleum Marketers Association of America, November 8, 1999, Docket A–99–06.

2007 to approximately 60% in 2012 based on typical fleet turnover rates. Thus, the amount of low sulfur fuel refiners would have to produce in the early years of the program could be reduced significantly, with a corresponding reduction in production costs theoretically as high as $4 billion, using our estimated per gallon fuel costs discussed in section IV. This theoretical distribution system does not exist and there would be a number of important and potentially significant costs incurred in the distribution system that could impact these savings. As discussed above, a wide array of entities in the distribution system, including refiners, bulk terminals, pipelines, bulk plants, petroleum marketers, fuel oil dealers service stations, truck stops, and centrally fuelled fleets would have to make investment decisions in order to distribute a second grade of highway diesel fuel. We seek comment on the potential cost savings associated with a phase-in approach, including the potential costs of managing two grades of highway diesel fuel in the distribution system, how these costs would vary depending on the relative volumes of the two grades of highway diesel fuel, the necessary margin for businesses in the distribution system to find it economic to manage two grades of highway fuel, and how these cost savings and margins could vary depending on the range of ways the distribution system might respond.

2. What Phase-in Options Is EPA Seeking Comment on in Today's Proposal?

In this section, we are requesting comment on three different phase-in approaches for implementing a program for low sulfur highway diesel fuel.

a. Refiner Compliance Flexibility

Despite the concerns described above with a phase-in approach for implementing the diesel fuel sulfur control program, EPA nevertheless believes that a program, if voluntary, can be devised which can address these concerns and take advantage of at least some of the benefits a phase-in approach has to offer. Consequently, as part of our proposed program for implementing low sulfur highway diesel, as described in section IV.C, we also are seeking comment on a voluntary option that would provide compliance flexibilities for refiners, while still achieving the environmental benefits of the program. In this section, we describe this refiner compliance flexibility concept and seek comment on all aspects of its design. We also discuss how this compliance flexibility relates to the options for small refiner flexibility (which we're seeking comment on in section VIII.E).

i. Overview of Compliance Flexibility

We are seeking comment on a voluntary compliance flexibility that would allow refiners to continue producing fuel at the 500 ppm level for a fraction of their total highway diesel fuel volume in the first few years of the program. The fraction of 500 ppm fuel allowed to be produced by refiners would phase-down over a period of several years. Specifically, we request comment on the appropriate fraction of highway diesel fuel allowed to be produced as 500 ppm fuel beginning in 2006. Three possible scenarios are shown in Table VI.A–1 below. The level at which this flexibility begins would significantly affect its design. We are seeking comment on a range of production percentages for the 500 ppm fuel. We are particularly interested in the degree to which percentages of 500 ppm at the higher end of this range could pose challenges for ensuring sufficient availability of the low sulfur fuel and minimizing the potential for misfueling. In addition, we request comment on the extent to which different proportions of 500 ppm fuel will pose different challenges for the distribution system. Several issues and implications of setting the 500 ppm production limits at higher or lower levels are discussed below. We seek comment on our assumptions and the implications of these issues for the design of such a compliance flexibility program. Further, we request comment on the number of years this flexibility should be provided.

TABLE VI.A–1.—TWO POSSIBLE SCENARIOS FOR IMPLEMENTING THE COMPLIANCE FLEXIBILITY

	Percent of highway diesel fuel permitted to be 500 ppm						
	2006	2007	2008	2009	2010	2011	2012
Scenario A	20	20	10	10	0	0	0
Scenario B	50	50	30	15	0	0	0
Scenario C	75	75	60	45	30	15	0

We believe this compliance flexibility would be potentially beneficial for refiners. This flexibility could reduce operating costs, by not requiring the entire volume of highway fuel to meet the low sulfur standard. With averaging, banking and trading provisions as a component of this compliance flexibility (as discussed below), some refineries may be able to delay desulfurization investments for several years. Even for refiners planning to desulfurize their entire highway fuel pool to low sulfur levels at the beginning of the program, there may be circumstances where the actual fuel produced is slightly off-spec (i.e., above the low sulfur standard). This flexibility would allow refiners to continue selling that fuel to the highway market (as 500 ppm fuel), rather than to other distillate markets. Refiners would also have more flexibility to continue producing highway diesel (as 500 ppm fuel) during unit downtime (e.g., turnarounds and upsets).

This approach would need appropriate safeguards to minimize contamination of the low sulfur fuel and misfueling. Thus, low sulfur highway diesel would have to remain a segregated product throughout its distribution (see further discussion of segregation requirements in section VI.A.2.a.v). Further, any retail pumps carrying 500 ppm fuel would have to be prominently labeled to prevent misfueling of 2007 and later model year vehicles. We seek comment on whether other measures to discourage misfueling might also be necessary. For example, the use of a unique refueling nozzle/vehicle nozzle interface could further discourage misfueling, although we question the need to pursue this approach if the 500 ppm fuel were in the market in relatively low volumes and only during the initial years when new vehicles still comprise a relatively small percent of the fleet. Other issues regarding the potential for misfueling are discussed in subsection 1 above.

We also propose an averaging, banking and trading (ABT) program as part of this compliance flexibility. Refiners owning more than one refinery would be allowed to average their production volumes across refineries in determining compliance. This could provide flexibility for some refining companies to delay making desulfurization investments at some smaller refineries for several years. Refiners also could generate credits based on the volume of low sulfur fuel produced above the required percentage. For example, if a refinery were required to produce a minimum of 80 percent of its highway diesel pool as low sulfur in the first year, and that refinery actually produced 100 percent of its highway diesel as low sulfur that year, it could generate credits based on the volume of the ''extra'' 20 percent of low sulfur fuel it produced. Those credits could be sold or traded with another refinery, which could in turn use the credits to produce a greater percentage of 500 ppm sulfur highway diesel fuel. More details on how these ABT provisions could be structured are discussed in section VI.A.2.a.iv below.

We believe a credit trading program may be particularly beneficial for refiners whose volumes of highway diesel are relatively small. It is possible that the credits generated by a refiner producing a large volume of low sulfur diesel could potentially be sufficient to offset a smaller refiner's entire highway diesel production, thereby enabling a smaller refiner to comply solely by the use of credits—and avoid desulfurization investments—for several years.

While we believe that a credit trading program could add meaningful flexibility under this approach, we are concerned about the potential for shortfalls in supply of low sulfur highway diesel in those areas supplied exclusively or primarily by refiners complying by the use of credits (i.e., producing only 500 ppm fuel). This situation could potentially occur, for example, in the Rocky Mountain area, or other areas served primarily by smaller refineries, or areas with relatively isolated fuel distribution systems. This concern becomes more salient as the percentage of 500 ppm fuel allowed to be produced increases. If the flexibility were to begin with 20 percent (of 500 ppm fuel) in the first year, the likelihood of a supply shortfall would be less likely than if the program begins with 50 percent (of 500 ppm fuel). Therefore, we seek comment on the extent to which this situation could occur and ways to structure the credit trading system to prevent low sulfur fuel supply shortfalls in any area, perhaps through regional restrictions in credit trading, or providing incentives for refiners to supply sufficient volumes of low sulfur fuel. We have been, and will continue, working with the Western states (for example, through the Western Governors Association) to discuss the best ways of implementing the program in that area.

Alternatively, we request comment on a regional approach to designing a compliance flexibility (for example, different refiner production levels and/ or availability provisions for different areas of the country). We seek comment on whether and how this compliance flexibility could be enhanced by such a regional approach, including information and data that would help us to better understand regional differences in highway diesel fuel supply, demand and distribution.

Refiners have expressed concern that under some phase-in approaches it might be difficult for them to recover their capital investments. We request comment this issue, including how the potential for cost recovery under a phase-in approach compares with that under the single-fuel approach, and what the implications are for the optimal production level of low sulfur diesel under the compliance flexibility approach.

We also invite comment on an alternative in which we simply establish a minimum production percentage for low sulfur fuel in the beginning of the program, and allow the market to take over in determining the appropriate supply and distribution from that point on. One concern with this approach is that it would perpetuate the potential for misfueling for as long as two grades of highway fuel remained in the market. We request comment on how long two grades of highway diesel would likely coexist in the market under this approach. Further, the level of this minimum low sulfur production percentage would have to be carefully designed to assure sufficient availability throughout the country. If you believe this or other alternative approaches would make the program more useful, please share your specific suggestions with us.

ii. What Are the Key Considerations in Designing the Compliance Flexibility?

A key consideration in designing this compliance flexibility is whether or not it should be accompanied by a retailer availability requirement. Under an availability requirement, diesel retailers would have to offer low sulfur fuel, but would have the flexibility to offer the 500 ppm fuel as well. We believe the need for an availability requirement is linked to the refiners' 500 ppm fuel production limits. At a 500 ppm fuel production limit beginning at 20 percent, our concerns for lack of availability and misfueling would likely be low enough not to warrant a retailer availability requirement or additional misfueling controls such as special nozzles. Our presumption is that if at least 80 percent of the highway fuel volume is low sulfur (i.e., a maximum 20 percent is 500 ppm), the low sulfur fuel should be sufficiently available across the country. Alternatively, if refiners were allowed to produce some greater proportion of their highway diesel fuel as 500 ppm fuel in the first few years, there would be a greater likelihood of low sulfur fuel supply shortfalls, lack of availability, and misfueling , and there would be a more compelling need to ensure that some minimum fraction of diesel retailers offered the low sulfur fuel. We request comment on the level of the 500 ppm fuel production limit at which concerns about low sulfur shortfalls, lack of availability, and misfueling would be great enough to warrant imposing a retailer availability requirement. We ask that commenters also consider whether they would prefer a ''blended'' program (i.e., a program with both a production limit on 500 ppm fuel and some form of a retailer availability requirement) to a program that permits a slightly lower level of 500 ppm fuel, but with no availability requirement.

In considering this issue, note that the percentage of low sulfur diesel fuel produced would not necessarily match the availability level. For example, if 80 percent of the highway fuel pool were low sulfur, this would not necessarily translate into the low sulfur fuel being available at 80 percent of retail stations currently selling diesel fuel. Since large retail stations (e.g., large truck stops) and centrally-fueled fleets represent a disproportionate share of the diesel sales volume, it is possible that the percentage of retail stations offering low sulfur fuel could be much lower than 80 percent of the diesel retail stations. If this were the case, would there still be concerns with lack of availability of the low sulfur fuel (e.g., even with 20 percent of highway fuel as low sulfur)?

We believe there are merits to designing this compliance flexibility in a way that avoids the need for a retailer availability requirement. With no availability requirement, retailers would be free to choose to sell 500 ppm fuel only, low sulfur fuel only, or both. We have heard from refiners and diesel marketers that they believe that retailers, if faced with an availability requirement, would likely decide not to carry both grades of fuel but, rather, would switch over to the low sulfur fuel to avoid the expense of installing new tanks and pumps. If this were true, an availability requirement could have the effect of significantly limiting a refiner's markets for its 500 ppm fuel, thus, limiting the benefits of the compliance flexibility approach. Nevertheless, we seek comment on whether an availability requirement for low sulfur diesel fuel should be a condition for retailers marketing 500 ppm fuel.

We seek comment on whether a retailer availability requirement would diminish the utility of the compliance flexibility approach, and at what point in designing this option (e.g., at what 500 ppm fuel production limit) a retailer availability requirement would become necessary to encourage sufficient availability of low sulfur fuel.

Since this compliance flexibility is voluntary, we anticipate that refiners would only produce and market 500 ppm fuel under the allowed percentages to the extent that the costs of distributing it are offset by savings elsewhere. The distribution system has only a limited ability to accommodate a second grade of highway diesel without incurring significant costs (e.g., installing new tankage). Therefore, while refiners may be able to reduce the costs of diesel fuel production if higher percentages of high sulfur diesel fuel are permitted, they may find it difficult to market 500 ppm fuel in volumes much above even the 20 percent level, due to distribution system costs. We request comment on the degree to which the distribution and retail costs associated with accommodating two grades of highway diesel fuel depend on the relative volumes of those fuels. For example, how would the costs incurred in the distribution system vary as the amount of 500 ppm fuel produced by refiners increases from zero to 50 percent, or even beyond?

iii. How Does This Compliance Flexibility Relate to the Options for Small Refiner Flexibility?

In section VIII.E., we seek comment on three approaches for small refiner flexibility. One of these approaches would allow small refiners to continue selling 500 ppm fuel for an unspecified period of time (although we seek comment on an appropriate duration for this flexibility). If the compliance flexibility approach described here were implemented for the refining industry as a whole, we seek comment on the best ways to meld this flexibility with approaches for minimizing the burden on small refiners. For example, we seek comment on whether it would be appropriate to either relax or remove any 500 ppm production limits for small refiners. In other words, we may consider allowing small refiners to continue selling their full production volume of highway diesel as 500 ppm fuel for some period of time (likely at least as long as the compliance flexibility provided to the refining industry as a whole, if not for some or an unlimited number of years beyond that). We request comment on the appropriate duration of this flexibility for small refiners. Further, we seek comment on whether small refiners should be allowed to generate and sell credits under the compliance flexibility's ABT program, even if small refiners are not required to produce any portion of their highway fuel as low sulfur diesel. The ABT approach could minimize the burden on small refiners by allowing them to make some additional profit to offset their desulfurization investments, thus giving them an incentive to produce low sulfur highway diesel fuel earlier than they otherwise would. We seek comment on other ways this compliance flexibility could be crafted to minimize burden on small refiners and to better meld with the approaches for small refiner flexibility described in section VIII.E.

It should be noted that our approach to allow small refiners to continue selling 500 ppm highway diesel (on which we're seeking public comment in section VIII.E.1.) does not include a retailer availability requirement. During the SBREFA process, small refiners expressed concern that an availability requirement would significantly limit their potential markets for 500 ppm fuel, since they believe that few retail outlets would be willing to offer both grades of highway diesel due to the significant costs of installing new tanks and pumps. Therefore, if this option for small refiner flexibility is promulgated in the final rule, we would reconsider its design in light of any decisions made for compliance flexibilities for the whole refining industry (e.g., the issue of whether an availability requirement would be necessary).

iv. How Would the Averaging, Banking and Trading Program Work?

This section discusses in more detail how we envision an averaging, banking and trading (ABT) program working in conjunction with the compliance flexibility approach. The goal of the ABT provisions is to maximize the flexibility provided by the program without diminishing its environmental benefits. We envision that this ABT program could apply to the program regardless of the actual level of the minimum refiner production requirement for low sulfur highway diesel. We request comment on all aspects of these ABT provisions. If you have ideas on how these provisions could be structured differently to enhance the program, please share your specific suggestions with us.

Averaging

Refiners and importers could be allowed to meet the required minimum percentage of low sulfur fuel production averaged over their entire corporate highway diesel pool. The minimum required percentage of low sulfur fuel production under the compliance flexibility would be determined on an annual average basis, across all refineries owned by that refiner (or all highway diesel fuel imported by the importer in the calendar year). Thus, within a given refining company, the volume of low sulfur fuel produced at one refinery could be below the minimum required percentage, so long as the volume produced at another refinery exceeded the minimum percentage by a sufficient amount such that the minimum required percent of low sulfur volume was met at the corporate level.

Generating Credits

Beginning in 2006, refineries and importers could generate credits based on the volume of low sulfur fuel produced above the required percentage. For example, a refinery produced 10 million gallons of highway diesel fuel in 2006 and was required to produce a minimum of 80 percent of its highway diesel volume (8 million gallons) as low sulfur that year. That refinery actually produced 100 percent of its highway diesel as low sulfur that year. Thus, it could generate credits based on the volume of the ''extra'' 20 percent of low sulfur fuel it produced above the required minimal percentage '' that is, 2 million gallons of credits. Under this program, we do not envision a need to establish a baseline volume of diesel fuel, since credits would be generated based on the volume of low sulfur diesel fuel actually produced above the required percentage.

Credits could be generated in each year that the compliance flexibility provisions are in place. In other words, if the duration of the compliance flexibility were for four years (i.e., refiners were allowed to continue producing some specified percentage of 500 ppm fuel for four years after the start of the low sulfur program), from 2006 through 2009, credits could be generated in each of those years.

We seek comment on whether there could be circumstances where the use of low sulfur highway diesel could be shown to demonstrate environmental benefits significant enough to warrant the generation of early credits. To the extent there may be circumstances that warrant early credit generation, we seek comment on whether there should be an appropriate discount factor applied to such credits, to ensure they would be comparable with the environmental benefits achieved by the use of low sulfur fuel in vehicles meeting today's proposed standards. See section IV.F.

As an additional aspect to implementing the compliance flexibility program, we seek comment on whether it would be advantageous for EPA to offer to sell additional ABT credits to refineries at a predetermined price. This would provide more certainty about the cost of supplying low sulfur diesel fuel by establishing a ceiling price on the ABT credits. We request comment on (1) what should be the appropriate predetermined price for these ABT credits; (2) whether there should be a cap on the total number of credits available from EPA to assure availability of low sulfur diesel; and (3) if there is a cap, whether credits should be sold on a first-come, first-serve basis.

Using Credits

Refiners and importers would be able to use credits to demonstrate compliance with the minimum required percentage of low sulfur highway diesel fuel, if they are unable to meet this requirement with actual highway diesel fuel production. Although credits would not officially exist until the end of the calendar year (based on the generating refinery's actual low sulfur fuel production) there is nothing to prevent companies from contracting with each other for credit sales prior to the end of the year, based on anticipated production. The actual credit transfer would not take place until the end of the year. All credit transfer transactions would have to be concluded by the last day of February after the close of the annual compliance period (e.g., February 28, 2007 for the 2006 compliance period).

For example, refiners who wish to purchase credits to comply with the 2006 required percentage of low sulfur fuel could do so based on the generating refinery's projections of low sulfur fuel production. By the end of February the following year, both the purchaser and the seller would need to reconcile the validity of the credits, as well as their compliance with the required percentages of low sulfur fuel produced.

We seek comment on allowing an individual refinery that does not meet the required percentage of low sulfur fuel production in a given year to carry forward a credit deficit for one year. Under this provision, the refinery would have to make up the credit deficit and come into compliance with the required low sulfur production percentage in the next calendar year, or face penalties. This provision would give some relief to refiners faced with an unexpected shutdown or that otherwise were unable to obtain sufficient credits to meet the required percentage of low sulfur fuel production.

We recognize that there is potential for credits to be generated by one party and subsequently purchased and used in good faith by another party, yet later found to have been calculated or created improperly, or otherwise determined to be invalid. Our preference would be to hold the credit seller, as opposed to the credit purchaser, liable for the violation. Generally, we would anticipate enforcing a compliance shortfall (caused by the good faith purchase of invalid credits) against a good faith purchaser only in cases where the seller is unable to recover valid credits to cover the compliance shortfall. Moreover, in settlement of such cases, we would strongly encourage the seller to purchase credits to cover the good faith purchaser's credit shortfall.

We believe that any person could act as a broker in facilitating credit transactions, whether or not such person is a refiner or importer, so long as the title to the credits are transferred directly from the generator to the purchaser. Whether credits are transferred directly from the generator to the purchaser, or through a broker, the purchaser needs to have sufficient information to fully assess the likelihood that credits would be valid. Any party that can generate and hold credits could also resell them, but the credits should not be resold more than twice. Repeated sales of credits could significantly reduce the ability to verify the validity of those credits.

How Long Would Credits Last?

The goal of these ABT provisions is to provide refiners additional flexibility in the early years of the low sulfur fuel program. After the first few years of the program, there would be a significantly greater proportion of aftertreatment-equipped vehicles in the fleet. It would be important to ensure a full transition to the new low sulfur fuel to prevent misfueling of those vehicles and preserve the environmental benefits of the program. Therefore, we do not currently envision allowing credits to be used more than a few years beyond the compliance flexibility period. We seek comment on whether credit lifetime should be limited, and if so on the appropriate length of time credits should be allowed to be used (in other words, the ''lifetime'' of credits).

v. Compliance, Recordkeeping, and Reporting Requirements

This section describes the types of provisions we believe the regulations would need to include if a compliance flexibility approach were adopted, to ensure that diesel fuel subject to the 500 ppm sulfur standard would not be introduced into model year 2007 and later diesel vehicles.

Refiners and importers of 500 ppm highway diesel fuel would be required to designate all highway diesel fuel produced as meeting the 500 ppm sulfur standard or meeting the proposed 15 ppm standard. Such refiners and importers would be required to maintain records regarding each batch of motor vehicle diesel fuel produced or imported, including the volume of each batch, and would be required to maintain records, and to report regarding credits earned and credit transactions. Reporting would also be required regarding volumes of highway diesel fuel produced or imported.

All parties in the distribution system that chose to carry 500 ppm fuel would be required to segregate that fuel from 15 ppm sulfur fuel, and would be responsible for ensuring that fuel designated as 15 ppm or 500 ppm meets the respective sulfur standards, throughout the distribution system. Such segregation requirements would likely be modeled after those of the reformulated gasoline (RFG) program (e.g., the RFG program's requirements for product transfer documents, refiners' designations of the standards to which each batch of fuel applies, and registration requirements for refiners producing both highway diesel fuels). However, the RFG program's segregation provisions are somewhat different, in that they were designed to segregate RFG from conventional gasoline by geographic area. In the highway diesel program, the segregation provisions would be much more widespread, because both grades of highway fuel could be distributed throughout the country, depending on how refiners choose to take advantage of the compliance flexibility. We seek comment on the need to require refiners producing 500 ppm fuel to conduct some form of downstream quality assurance sampling, similar to the surveys required under the RFG program.

Further, all parties in the distribution system would be subject to prohibitions against selling, transporting, storing, or introducing or causing or allowing the introduction of diesel fuel having a sulfur content greater than: (1) the proposed 15 ppm standard into highway diesel vehicles manufactured in the 2007 model year and beyond; and (2) 500 ppm into any highway vehicle. Under the proposed presumptive liability scheme (as discussed in section VIII.A.8), if a violation is found at any point in the distribution system, all parties in the distribution system for the fuel in violation are responsible unless they can establish a defense. Because of our concerns for contamination and misfueling with having two grades of highway diesel in the market, we seek comment on whether a refiner should lose its flexibility to continue producing 500 ppm fuel if it is found liable for a violation.

All parties handling 500 ppm fuel also would be required to maintain product transfer documents for five years that indicate to which highway diesel fuel standard the fuel is subject. Pump labels would be required at retail outlets and wholesale purchaser-consumer facilities providing notice regarding the different highway fuel types and the vehicles they may/may not be used in. As mentioned above, nozzle requirements might also be considered if the minimum volume requirement for low sulfur diesel is low enough to warrant it.

The rule would prohibit any refiner from producing more 500 ppm highway diesel fuel than allotted, and would prohibit any party from distributing or selling diesel fuel not meeting the proposed 15 ppm standard unless it is properly designated and accompanied by appropriate product transfer documents. The rule would also prohibit any person from introducing or causing or allowing the introduction of highway diesel fuel not meeting the 15 ppm sulfur standard into any model year 2007 or later vehicle.

As with any ABT program, we would need refiners to keep appropriate records, and to file necessary reports, to ensure compliance as well as the integrity of any credit generation, trading, and use. If this program is promulgated in the final rule, we would envision that refiners would likely be required to keep records of key information pertaining to the ABT program. Beginning the first year that credits are generated, any refiner for each of its refineries, and any importer for the highway diesel fuel it imports, would keep information regarding credits generated, separately kept according to the year of generation. We envision that refiners would keep records of the following information, at a minimum, and report such information to EPA on an annual basis, for any year in which credits are generated, transferred, or used:

- The total volume of highway diesel fuel produced
- The total volume of highway diesel fuel produced meeting the 500 ppm sulfur standard
- The total volume of highway diesel fuel produced meeting the low sulfur standard
- The total volume of highway diesel fuel produced (delineating both 500 ppm fuel and low sulfur fuel) after inclusion of any credits
- The number of credits in the refiner's or importer's possession at the beginning of the averaging period
- The number of credits used
- If any credits were obtained from or transferred to other parties, for each other party, its name, its EPA refiner or importer registration number, and the number of credits obtained from or transferred to the other party;
- The number of credits in the refiner's or importer's possession that will carry over into the next averaging period
- Contracts or other commercial documents that establish each transfer of credits from the transferor to the transferee
- The calculations used to determine compliance with the minimum required percentage of low sulfur highway diesel fuel
- The calculations used to determine the number of credits generated

b. Refiner-Ensured Availability

An alternative concept suggested to the Agency to accomplish the objective of ensuring widespread availability of low sulfur diesel fuel while still allowing flexibility for producing less than all of the diesel fuel pool as low sulfur is to have the refiners ensure that it is widely available. The base program would still be a requirement that refiners produce only highway diesel fuel which meets the sulfur standard proposed today. However, refiners could voluntarily choose to participate in a program where they would be allowed to sell a larger fraction of their highway diesel fuel as 500 ppm fuel, in exchange for ensuring that low sulfur diesel fuel is made widely available at the retail level.

This concept may entail a refinery contracting with, or purchasing credits from, retailers, who in exchange for incentives from the refiner, agree to make low sulfur diesel fuel available. This could mean that the retailer decides to switch over entirely to selling low sulfur diesel fuel, or that they offer both low sulfur and high sulfur diesel fuel simultaneously. The retailer would have to make a showing that: (1) the low sulfur diesel was ''meaningfully'' available; (2) there was an assured supply chain for obtaining low sulfur diesel fuel; and (3) the diesel fuels were segregated and properly labeled at the pumps. ''Meaningfully'' available might mean having dedicated pumps and tankage for low sulfur diesel with a capacity in the thousands of gallons range, and operating all year long. To be clear, the contract/credits would be for making low sulfur diesel available for sale, not necessarily selling a given volume of low sulfur diesel.

The relief that refiners receive in exchange for providing for low sulfur availability could be calculated on the basis of the retailer's total diesel sales volume. For example, the refiner would be permitted to produce a certain volume of highway diesel fuel at the current 500 ppm cap in proportion to the total diesel sales volume of the retailers that the refiner contracts with (or purchases credits from). A ratio could be applied to the retailer's sales volume to ensure sufficient retail availability.

An example of how this concept might work is as follows: A refinery producing highway diesel fuel contracts with several truck stops and service stations to make low sulfur fuel available at their stations. The refiner would then be permitted to produce 500 ppm grade diesel fuel in an amount up to the combined diesel sales volume (or some multiple thereof) for these retailers. The retailers may receive their low sulfur diesel fuel from this refiner or from other refiners to comply with the contract.

Under this approach, refiners would likely make arrangements with, or purchase credits from, the largest retailers (since they have the largest fuel volumes), in order to minimize transaction costs. Because the largest 5 percent of diesel retail stations represent 60 percent of the sales volume,[152] to achieve any meaningful availability of low sulfur fuel at retail stations, the program may require a considerably larger percentage of the sales volume to be targeted by weighting more heavily credits generated by smaller retail outlets.

We ask for comment on this concept, on its advantages and disadvantages compared to other implementation options, on the percentage of retail outlets that may be sufficient under this concept to achieve satisfactory low

[152] Memorandum to Docket A–99–06 from Jeffrey Herzog, EPA, entitled: ''Diesel Throughput Volume by Percentage of Diesel Fuel Retailers,'' May 5, 2000.

sulfur diesel fuel availability, on means of ensuring adequate geographic distribution of low sulfur diesel fuel throughout the year, and on the appropriate means of calculating the volumes that refiners should be permitted to produce as high sulfur in exchange for making low sulfur available. We also request comment on how such a program could be implemented and enforced. In particular, we request comment on the type of recordkeeping and reporting EPA should require in ensuring a refiner actually has legitimate credits, contracts or other binding arrangements with retailers to make low sulfur diesel fuel ''meaningfully'' available. We further request comment on whether and what type of recordkeeping and reporting may be necessary for retailers and distributors, particularly if the program were structured to allow retailers to generate and sell credits.

c. Retailer Availability Requirement

One way of ensuring widespread availability of the low sulfur fuel under a phase-in approach would be to require retailers selling highway diesel to make available the low-sulfur diesel (i.e., a retailer availability requirement). Retailers would be free to sell the current 500 ppm sulfur fuel as well, but at a minimum would have to offer the low sulfur fuel. This approach could either be a stand-alone program design (i.e., with no refiner production requirement for a minimum amount of low sulfur diesel), or could be coupled with a refiner production requirement. Retailers would be responsible for getting low-sulfur diesel from the distribution system. The premise of this approach is that the fuel distribution system would react to the market demands, and supply and distribute the second grade of fuel in all parts of the country.

In order to turn this premise into a reality, the fundamental issues associated with a phase-in approach, as discussed in subsection 1 above, would have to be addressed. Consequently, in the context of an availability requirement, we seek comment on how to resolve the concerns raised in subsection 1. With regard to the structure of such an availability requirement, we seek comment on when it should begin, whether it could be limited to just a fraction of the diesel fuel retail outlets, and what fraction would constitute acceptable availability in the marketplace. We specifically request comment on the merits of limiting an availability requirement to the larger diesel retailers. Under such an approach, the larger diesel retailers would have to carry low sulfur diesel, but could also choose to carry the 500 ppm grade as well. Smaller retailers not subject to the availability requirement would have the flexibility to choose to carry only the low sulfur grade, only the 500 ppm grade, or both. For example, we seek comment on the merits of limiting the requirement to only truck stops selling more than 200,000 gallons of diesel fuel per month, and other retail outlets selling more than 20,000 gallons of diesel per month, as suggested by some Panel members during the Small Business Advocacy Review process. We encourage commenters to consider other appropriate throughput thresholds, for both truck stops and service stations that could limit an availability requirement to the larger retailers, while still ensuring sufficient availability.

While desirable to limit the fraction of retailers subject to an availability requirement, ensuring sufficient availability is complicated by the fact that diesel fuel is sold at a portion of all retail outlets today.[153] If less than 100 percent of diesel retail outlets are required to make the new fuel available, how would we ensure availability in all parts of the country? Commenters should consider the distribution of diesel fuel outlets around the country, and the distances between outlets in addressing this issue. How would the rest of the distribution system respond to supply the low sulfur fuel to the retail outlets needing to make it available? To help protect against fuel shortages either nationally or regionally, would an availability requirement need to be coupled with a production requirement on refiners to ensure supply of a minimum amount of low-sulfur diesel fuel? If so, how should such a production requirement be structured? Conversely, could an availability requirement be coupled with a production requirement in a way that would allow a larger percentage of 500 ppm fuel production in the early years? (See the discussion above in subsection 2.a.ii)

With regard to the impacts on the diesel fuel retail and distribution system, numerous parties in the industry have commented that managing two grades of highway diesel in the distribution system would raise their costs. We seek comment on what actions retailers, centrally fueled fleets, wholesalers, terminals, pipelines, and refiners would take to manage two grades of highway diesel, and in particular on the cost impacts resulting from those actions. We especially seek comment on what cost savings refiners might realize under such an approach, and whether these savings would be greater than the costs incurred by the distribution system to distribute a second grade of highway diesel fuel. In this context, we also seek comment on how refiners would plan their refinery changes given the uncertainty of low sulfur diesel demand from retailers under such a phase-in approach. When would they make their capital investments, and for what volume of fuel would they plan to build desulfurization capacity? How would they predict demand in the time frame when they would need to make their capital investments? How would they adjust to different volumes from predicted demand levels, and what would be the implications?

Commenters should address this approach from the perspective of the issues discussed above in subsection A.1 (including misfueling, distribution system impacts, potential costs, etc). We are also interested in the implications of such an approach on prices in the wholesale and retail markets, and on the ability of retailers and distributors to recover costs under such an approach.

We also invite comment on the merits of applying an averaging, banking and trading program within the context of a retailer availability requirement. Such a credit trading program could entail elements similar to the program described in subsection 2.a.v. for refiners under the compliance flexibility approach, but would be tailored specifically to retailers subject to an availability requirement. Commenters should address how such a credit trading program might be structured, if they believe it should differ significantly from the refiner-based approach discussed above.

Finally, the trucking industry and diesel marketers have also commented that an availability requirement would be administratively intensive for the Agency to implement and enforce, especially in verifying actual fuel availability. Therefore, we ask comment on ways to streamline the enforcement of such a program to avoid unnecessary burden on both industry and the Agency.

2. Why Is a Regulation Necessary to Implement the Fuel Program?

Some commenters on the ANPRM suggested simply leaving it up to the market to introduce low-sulfur highway diesel fuel—that is, establish no regulatory requirements for refiners to produce the fuel and no requirements for retailers to sell the fuel. The

[153] ''Summary Data on Diesel Fuel Retailers,'' Memo to the docket from Jeffrey Herzog, EPA, March 23, 2000 (Docket item # II–B–07).

commenters' line of reasoning for this suggestion is as follows. The vehicle and engine manufacturers would be forced by emission standards to introduce vehicles meeting stringent emission standards. Since the engines and vehicles would need low-sulfur diesel fuel to meet the emission standards, then the vehicle purchasers would have to refuel only with low-sulfur diesel fuel. The fuel production and distribution system would then respond to the demand and provide the fuel if, when, and where necessary.

Such an approach raises many of the same issues discussed above with respect to phase-in approaches (*e.g.,* fuel availability, misfueling, and uncertainties in the transition to low sulfur). These concerns, however, would be heightened by the fact that no regulatory measures would be in place to mitigate them. We seek comment on whether a market-based approach could adequately ensure availability of the low sulfur fuel for the vehicles that need it.

3. Why Not Just Require Low-Sulfur Diesel Fuel for Light-Duty Vehicles and Light-Duty Trucks?

In the ANPRM, we requested and received considerable comment on focusing the rulemaking effort on providing low-sulfur diesel fuel for light-duty vehicles and trucks only. By providing a clean grade of diesel fuel, exhaust emission control technology would be enabled. This in turn would give light-duty diesel vehicles a much better chance of meeting the final Tier 2 emission standards. The appeal of a light-duty only approach is that the program would be relatively small and could set the stage for future expansion of low-sulfur diesel fuel into the heavy-duty market if the demand developed.

Based on the comments received on the ANPRM and our own analysis, however, there appears to be little justification for such a regulatory approach. First, and most importantly, such an approach would provide no environmental benefit to justify the costs of the program. Under the Tier 2 program, all LDVs and LDTs must meet on average a certain NO_X emission standard. There are a number of emission standards or ''bins'' that individual vehicles can be certified to, but an overall fleet average emission standard must still be met. Consequently, regardless of whether or not the Tier 2 fleet is comprised of a large number of diesel vehicles, the same overall fleet average NO_X emission rate will be achieved. The only anticipated difference would be in particulate emissions where, even though the emission standards are the same, in-use emissions are assumed to be somewhat lower for gasoline vehicles than for diesel vehicles. In contrast, today's proposed program for setting new emission standards for heavy-duty engines and vehicles in conjunction with lower sulfur highway diesel fuel would achieve significant reductions in NO_X and particulate matter, as discussed further in section II.

Secondly, the comments received on the ANPRM from the fuel production and distribution system indicated that such an approach would be very costly. The Engine Manufacturers Association conducted a study of the cost increase associated with distributing a unique grade of diesel fuel for just light-duty vehicles and trucks.[154] The results of this study indicated that the distribution costs alone (i.e., not including refiner production costs) for such a fuel could be 3 to 4 cents per gallon. Moreover, this study made some simplifying assumptions that served to underestimate actual volume of highway diesel fuel that would have to be produced and the costs. The study assumed a production volume of 5 percent low sulfur diesel, which is not realistic because many retailers might choose to switch over entirely to the low sulfur fuel. Thus, refiners would have to make the investments to produce a considerably larger volume of low sulfur diesel fuel than might be required for new light-duty vehicles and trucks only.

Third, commenters indicated that such an approach may be impractical. In areas where there are few fuel distribution options (e.g., areas not served by pipelines, areas with few diesel retail outlets), the low-sulfur diesel fuel may not be made available or, if it is, it could only be sold at retail prices considerably higher than the refiners' cost to produce the fuel. Consumer demand for light-duty diesel vehicles could be reduced by both unavailability of the low sulfur fuel and uncertainty about it being available at reasonable prices.

Finally, a light-duty only approach would appear to be inappropriate in light of our demonstrated air quality need for additional emission reductions and the opportunity available with recent advancements in diesel engine exhaust emission control technology to obtain these emission reductions from heavy-duty engines. If the technology necessary to meet very low emission standards for light-duty diesel vehicles is feasible with the control of diesel fuel sulfur, and if that same technology is applicable to heavy-duty diesel vehicles, then we have an obligation under the Clean Air Act to consider emission standards for heavy-duty vehicles that would be enabled by that technology as well. Given the air quality need, we would be remiss in our obligations under section 202(a)(3)(A) of the Act which requires us to set the most stringent standards feasible for heavy-duty vehicles, taking into consideration cost and other factors. EPA can revise such standards, however, based on available information regarding the effects of air pollutants from heavy-duty engines on public health or welfare.

4. Why Not Phase-Down the Concentration of Sulfur in Diesel Fuel Over Time as Was Done With Gasoline in the Tier 2 Program?

There are a number of ways a fuel change can be introduced over time. The most recent example is in the Tier 2 rulemaking where the concentration of sulfur in gasoline was phased-down over time. Such an approach is not workable for diesel fuel, however, due to the demands of the exhaust emission control technology. As discussed in section III, the efficiency of both the NO_X and PM exhaust emission control drops off quickly if the vehicle is operated on sulfur levels higher than the standard proposed. Thus, the vehicles would be unable to meet the emission standards, and there would be very little if any emission benefit to be gained until the end of any such phase-down. Furthermore, as discussed in section III, in some applications it is possible that operation on higher sulfur levels may not only cause permanent damage to the PM trap, but also could result in vehicle driveability and safety concerns. Consequently, it is imperative that aftertreatment-equipped vehicles are fueled exclusively with fuel meeting the proposed low sulfur levels, and that the low sulfur fuel remain segregated in the distribution system.

This contrasts with the gasoline sulfur control program, where the impact of sulfur on the exhaust emission control technology was thought to be less severe and emission benefits accrued even at the phased-down sulfur levels. Furthermore, if gasoline vehicles are operated on higher sulfur fuel, no driveability concerns are anticipated; higher sulfur diesel would have detrimental effects on the driveability of diesel engines. Thus, in the gasoline sulfur program there was not a need to require that low sulfur gasoline remain segregated from the remaining gasoline pool while sulfur levels are being phased-down. Here there is a need to

[154] ''Very-Low-Sulfur Diesel Distribution Cost,'' Baker & O'Brien Inc., for the Engine Manufacturers Association, August 1999.

segregate low sulfur highway diesel fuel to ensure the new technology vehicles are not damaged by higher sulfur levels.

B. What Other Fuel Standards Have We Considered in Developing This Proposal?

1. What About Setting the 15 ppm Sulfur Level as an Average?

We have considered several potential diesel fuel sulfur alternatives in developing today's proposed rulemaking, including two alternatives centered around a 15 ppm sulfur level: a cap at this level as proposed, and an average at this level with a 25 ppm cap to ensure that sulfur levels would not exceed a 15 ppm average level by too much. The analyses of technology enablement, costs, emission reductions, and cost effectiveness discussed in the preceding sections are based on a 15 ppm cap. In this section we provide the results of these analyses for the 15 ppm average sulfur level case.

a. Emission Control Technology Enablement Under a 15 ppm Average Standard

Having a 15 ppm average standard with a 25 ppm cap would increase uncertainty around the advanced technologies required here and would therefore be less attractive to diesel engine and vehicle manufacturers. As discussed at length in Section III, fuel sulfur adversely impacts the effectiveness of all known and projected exhaust emission control devices. Despite these adverse effects, it may be possible that the design, precious metal loading, and application of exhaust emission control devices could be fundamentally similar under both a 15 ppm cap and a 15 ppm average. However, we would expect that the exhaust emission control devices would not operate at the same level of efficiency as expected under the 15 ppm cap program and there would be some sacrifice in the durability and reliability of these devices due to the higher sulfur level.

PM trap regeneration would be compromised due to sulfur's adverse impacts on the NO to NO_2 conversion necessary for completely passive PM trap regeneration.[155] Because of this effect, concerns have been raised that a 15 average/25 cap program would require that some vehicle applications, particularly lighter applications having lower operating temperatures, incorporate some form of active PM trap regeneration strategy. Such an active regeneration strategy could take the form of a fueling strategy capable of increasing exhaust temperature as opposed to an electrical heater or some other ''added'' hardware. The active regeneration scheme would likely be incorporated into the design as a backup, or protective measure, and would not function at all times. Instead, the active regeneration would kick in under conditions such as very cold ambient temperature conditions or extended idles where exhaust temperatures might be too low for too long to enable passive regeneration. There are also concerns that fuel economy would be reduced both due to the use of active regeneration and due to the higher, on average, PM trap backpressure. This would likely occur due to the slightly higher soot loading, on average, resulting from less efficient passive trap regeneration. This higher backpressure would probably occur on all applications, not just the lighter applications. Nonetheless, we believe that the fuel economy effect would probably not be greater than one percent.

Under a 15 ppm average standard, we would expect the in-use average sulfur level to be roughly double the in-use average under a 15 ppm cap program. The higher in-use sulfur level would roughly double in-use PM emissions. Since an average limit would be in place and be enforced, and since in-use emissions would be expected to approximate the average, we might consider allowing engine manufacturers to certify their engines on diesel fuel meeting the average sulfur level rather than the cap. If this approach were taken, setting the sulfur standard at a 15 ppm average instead of a 15 ppm cap would not necessitate an increase in the PM standard. However, in-use PM emissions would nearly double due to the increased average fuel sulfur level (when compared to the 15 ppm cap base case).

Regarding the NO_X adsorber, we believe that a 15 average/25 cap program may have the potential to enable NO_X adsorber technology, though with increased uncertainty. However, while the NO_X adsorber would continue to adsorb and subsequently reduce NO_X despite the higher sulfur fuel, the frequency of sulfur regeneration events, referred to as desulfation in section III, would roughly double relative to the rate with a 15 ppm cap. The increased frequency of desulfation would increase fuel consumption probably on the order of one percent and would be realized on all diesel applications equipped with NO_X adsorber technology.[156] Additionally, the increased frequency of desulfation may adversely impact NO_X adsorber durability because the thermal strain placed on the adsorber during any desulfation event would increase in frequency. Also, because of the increased frequency of desulfation events, there would be a corresponding decrease in the likelihood of being able to perform the desulfation during ideal operating conditions. This may cause more thermal strain on the NO_X adsorber and/or less efficient desulfation with a corresponding increase in fuel usage. The result would be a decrease in our level of confidence that the NO_X adsorber would be capable of fulfilling the demands of heavy-duty diesel engines in terms of fuel consumption and durability.

Note that, although the analysis finds that a 15 ppm average/25 ppm cap standard has potential to be adequate for enabling high-efficiency exhaust emissions controls, this finding involves a significantly higher level of uncertainty than the proposed 15 ppm sulfur cap, because it is based on the assumption that exhaust emission control designs could be focused on the average fuel sulfur levels. Manufacturers have commented that the possibility of some in-use fuel at near-cap levels would necessitate designing to accommodate this level, and they contend that this would not allow the high-efficiency technology to be enabled. If so, the technology enablement for this case would likely be similar to that for the 50 ppm cap case.

b. Vehicle and Operating Costs for Diesel Vehicles To Meet the Proposed Emissions Standards With a 15 ppm Average Standard

As pointed out above, we believe it may be possible that the design, precious metal loading, and application of exhaust emission control devices could be fundamentally similar under both a 15 ppm cap and a 15 ppm average. Therefore, we believe that having a 15 ppm average sulfur standard would have no quantifiable impact on the cost of emission control hardware relative to the costs associated with a 15 ppm cap standard. However, as mentioned, we would expect a one percent fuel economy decrease (*i.e.,* a one percent increase in fuel consumption) due to the increased frequency of desulfation of the NO_X adsorber. This reduction in fuel economy would result in consumption

[155] Cooper and Thoss, Johnson Matthey, SAE 890404.

[156] See section III and Table III.F–2 for more detail on desulfation and the associated fuel economy impacts.

of more fuel and, therefore, higher costs. We have estimated the discounted lifetime cost of this one percent fuel economy impact at $108, $207, $755, and $893 for a light, medium, and heavy heavy-duty diesel, and urban buses, respectively. See the draft RIA for details on how this cost was calculated.

c. Diesel Fuel Costs Under a 15 ppm Average Standard

Having a 15 ppm average with a 25 ppm cap sulfur standard would be directionally more attractive to the petroleum industry because of the slightly higher sulfur levels. Overall, we would expect this approach to provide more flexibility to refiners and distributors, and directionally help in addressing concerns that have been expressed about the difficulties of distributing diesel fuel with very low sulfur specifications. The cost of meeting a 15 ppm sulfur average at the refinery (with a 25 ppm cap) would be significantly less than meeting the proposed cap of 15 ppm. We project that roughly half of all refiners would be able to meet a 15 ppm average by modifying their existing one-stage hydrotreating unit by adding a hydrogen sulfide scrubbing unit, a PSA unit to increase hydrogen purity and a second reactor. A new, high activity catalyst would also replace today's catalyst. Refiners who would be capable of meeting a 15 ppm average with a one-stage unit would likely be those blending low amounts of light cycle oil (LCO) into their diesel fuel or those having substantial excess hydrotreating capacity in their current unit. The remaining refiners would require essentially the same two-stage hydrotreating unit that would be required to meet the proposed 15 ppm cap. In all cases, hydrogen consumption would be somewhat less than that required to meet the proposed 15 ppm cap standard.

As for fuel distribution, under the proposed 15 ppm cap on diesel sulfur content, we estimate that sulfur contamination in the distribution system can be adequately controlled at modest additional cost through the consistent and careful observation of current industry practices. A 0.2 cent per gallon increase in distribution cost is anticipated due to the need for an increase in pipeline shipment interface volumes, increased quality testing at product terminals, and the need to distribute an increased volume of fuel to meet the same level of consumer demand due to a reduction in energy density. Having a 15 ppm average standard would mean that the increase in pipeline interface volumes would likely be somewhat smaller than under the proposed 15 ppm cap. However, we do not expect that the savings in interface volumes would be proportional to the difference between the standards. This is due to the similarity of the alternative standards with the proposed 15 ppm sulfur cap relative to their comparison with the sulfur level of other products in the distribution system such as nonroad diesel fuel (3,400 ppm average sulfur content). Consequently, we estimate that distribution costs under a 15 ppm average standard would only be marginally lower (approximately 0.003 cents per gallon less) than under the proposed 15 ppm cap.

Overall, we project that the average cost of meeting the 15 ppm average at the refinery would be about 3.0 cents per gallon, about 1.0 cents per gallon less than the corresponding cost for fuel meeting a 15 ppm sulfur cap. Adding the cost of lubricity additives and increase in distribution costs, the final cost for the 15 ppm average/25 ppm cap fuel would be 3.4 cents/gallon, as compared to 4.4 cents per gallon under the proposed 15 ppm cap standard.

d. Emission Reductions Under a 15 ppm Average Standard

As discussed above, we believe that the same basic exhaust emission control technology could be used to reduce exhaust emissions from HDDEs even if we required a 15 ppm average rather than a 15 ppm cap. However, as pointed out above, there would likely be penalties in durability, fuel consumption, and emissions.

At this higher fuel sulfur level, we believe that the particulate trap will still result in large reductions of HC, CO, and carbon soot. We also believe that the 0.2 g/bhp-hr NO_X standard may be achieved using a NO_X adsorber. Nonetheless, the total PM reductions would be lower under a 15 ppm average standard. Sulfur in the fuel impacts the amount of direct sulfate PM in the exhaust gas. We estimate that a 15 ppm average standard would result in almost double the total PM emissions as compared to a 15 ppm cap standard because the 15 ppm cap is assumed to result in a 7 ppm in-use average. Table VI.B–1 presents projected nationwide HDDE PM emissions for the baseline and control case for a 15 ppm average/25 ppm sulfur cap standard along with the corresponding reductions. For comparison, the same information is shown for the proposed 15 ppm cap. Refer to the draft RIA for details of this analysis.

TABLE VI.B–1.—HDDE PM EMISSIONS WITH A 15 PPM AVERAGE/25 PPM SULFUR CAP

[Thousand short tons]

Calendar year	Baseline	15 ppm average	15 ppm cap (for comparison)
		Controlled	Controlled
2007	100	89	88
2010	94	60	59
2015	93	33	30
2020	98	19	15
2030	119	13	8

A higher average sulfur level also results in lower SO_X emission reductions. We assume that the sulfur in the fuel that is not converted to sulfate PM is converted to SO_2. Because we base SO_X emissions on the amount of sulfur flowing through the engine, the increase in fuel consumption also negatively impacts SO_X emissions. Table VI.B–2 presents projected nationwide HDDE SO_X reductions for a 15 ppm average/25 ppm sulfur cap standard and for the proposed 15 ppm cap.

TABLE VI.B–2.—HDDE SO_X EMISSION REDUCTIONS WITH A 15 PPM AVERAGE/25 PPM SULFUR CAP

[Thousand short tons]

Calendar year	15 ppm average	15 ppm cap
2007	86	88
2010	91	93
2015	99	102
2020	107	109
2030	120	123

e. Cost Effectiveness of a 15 ppm Average Standard

The methodology used to determine the cost-effectiveness of a 15 ppm average sulfur standard follows that described in Section V for our proposed 15 ppm cap standard. The alternative standard of 15 ppm on average does have impacts on specific values in the calculations, including lower desulfurization and distribution, lower in-use PM benefits, and lower SO_2 benefits all of which were pointed out above. Engine costs are assumed not to change under either a 15 ppm cap or 15 ppm average standard. We have calculated cost-effectiveness using both the per-vehicle and aggregate approaches, consistent with our cost-effectiveness presentation in Section V for our proposed program. The results are shown in Tables VI.B–3 and VI.B–4 which can be directly compared to Tables V.F–1 and V.F–2, respectively, showing values for the proposed 15 ppm cap standard. Details of the calculations are presented in the draft RIA which can be found in the docket for this rulemaking.

TABLE VI.B–3.—PER-VEHICLE COST-EFFECTIVENESS OF A 15 PPM AVERAGE/25 PPM CAP SULFUR STANDARD

Pollutants	Discounted lifetime vehicle & fuel costs	Discounted lifetime emission reductions (tons)	Discounted lifetime cost effectiveness per ton	Discounted lifetime cost effectiveness per ton with SO_2 credit [a]
Near-term costs:[b]				
NO_X + NMHC	$1,565	0.88	$1,800	$1,800
PM	774	0.064	12,100	5,200
Long-term costs:				
NO_X + NMHC	$1,151	0.88	$1,300	$1,300
PM	554	0.064	8,700	1,800

[a] $440 credited to SO_2 (at $4800/ton) for PM cost effectiveness.

[b] As described above, per-engine cost effectiveness does not include any costs or benefits from the existing, pre-control, fleet of vehicles that would use the low sulfur diesel fuel proposed in this document.

TABLE VI.B–4.— 30-YEAR NET PRESENT VALUE COST-EFFECTIVENESS OF A 15 PPM AVERAGE/25 PPM CAP SULFUR STANDARD

	30-year NPV costs (billion)	30-year NPV reduction (million tons)	30-year NPV cost effectiveness per ton	30-year NPV cost effectiveness per ton with SO_2 credit [a]
NO_X + NMHC	$26.4	18.9	$1,400	$1,400
PM	$8.0	0.75	$10,700	$1,100

[a] $7.2 billion credited to SO_2 (at $4800/ton).

2. What About a 5 ppm Sulfur Level?

Some diesel engine and automobile manufacturers have expressed support for a sulfur cap of 5 ppm (sometimes termed ''near-zero'') for some or all of the highway diesel fuel pool.[157] They view the technology solutions envisioned in this rulemaking to be infeasible at higher fuel sulfur levels. Although the feasibility analysis results of this proposal lead us to disagree with this conclusion, we have evaluated the impact that a 5 ppm sulfur cap would have on technology enablement, vehicle and fuel costs, and emissions reductions. The results of this analysis are provided below. Analysis details are provided in the Draft RIA. We encourage comment on our assessment, preferably accompanied by data and analysis supporting the commenter's views.

Capping diesel fuel sulfur at 5 ppm would clearly strengthen the viability of new emissions control technologies enabled at 15 ppm, although we are aware of no additional technologies that this lower sulfur level would enable. PM traps would emit somewhat less sulfate PM, but non-sulfate PM emissions and certification test measurement tolerances would effectively limit the extent to which the standard could be lowered from the proposed 0.01 g/bhp-hr level at this time. Given the level of precision implicit in the 0.01 numerical standard, we would not expect a 5 ppm sulfur cap to result in a lower PM standard. Nevertheless, there would be an in-use benefit compared to a 15 ppm cap, because the average fuel sulfur would be lower (perhaps 2–3 ppm compared to about 7 ppm) and so new vehicles

[157] See for example letter from Patrick Charbonneau of Navistar to Robert Perciasepe of EPA dated July 21, 1999, EPA, docket A–99–06.

would emit less sulfate PM, providing a projected 86,000 ton per year PM benefit in these vehicles in 2020, compared to 83,000 tons per year achieved under a 15 ppm cap. We have assumed that the small margins involved and the extremely high trapping efficiencies of filters that are already readily available would give manufacturers no incentive to take advantage of the lower sulfate emissions to design for higher non-sulfate emissions under the standard.

Lower sulfate PM emissions in the *existing fleet* would provide a 105 tons per year additional PM benefit (in 2007 when this benefit peaks) from adoption of a 5 ppm sulfur cap compared to a 15 ppm cap. However this is quite small compared to the corresponding 7100 ton per year existing fleet PM benefit of reducing fuel sulfur from typical current average levels of around 340 ppm to levels near 15 ppm, which in turn is a small fraction of the total direct PM emissions benefit of the 15 ppm cap, most of which comes from enabling PM traps on new engines (see Figure II.D–2). SO_X and SO_X-derived secondary PM would also be reduced in about the same small proportion.

The robustness of the PM trap regeneration process would also be directionally aided by the near zero sulfur fuel, because less of the catalyst sites that promote regeneration would be blocked by sulfur poisoning. (This phenomenon is described in section III.F.1.a). In fact, designers could further increase regeneration robustness by increasing precious metal loading without fear of inordinate sulfate production because of the lower fuel sulfur level (though at added cost). However, we have not quantified this directional benefit or cost difference because we deem the 15 ppm level adequate for robust regeneration already.

Five ppm sulfur fuel would also benefit NO_X adsorber technology. Adsorber desulfation would be needed about four times less often than that required under a 15 ppm sulfur cap, providing a projected 1 percent improvement in fuel economy. There may also be a small gain in NO_X adsorber durability due to the less frequent thermal cycling built into the desulfation process. However, available evidence suggests that at any fuel sulfur level under 15 ppm, these cycles are not likely to be so numerous or severe over the vehicle life as to seriously constrain durability. NO_X emissions would not be much affected because the basic NO_X storage and removal processes would occur in much the same way, and desulfation events would be programmed to occur frequently enough to maintain NO_X reduction efficiencies high enough to meet the standard with a minimum of fuel consumption.

We have not performed an extensive analysis of the refining cost of meeting a 5 ppm sulfur cap. However, Mathpro, under contract to EMA, did estimate the refining cost of producing diesel fuel with an average sulfur level of 2 ppm, a reasonable average under a 5 ppm cap. Mathpro examined two sets of cases where average on-highway diesel fuel sulfur levels were reduced from 20 ppm to 2 ppm, one with nonroad diesel fuel sulfur at 350 ppm (Cases 1 and MP1) and the other with nonroad diesel fuel sulfur at 20 ppm (Cases 4 and 8). From these cases, Mathpro's estimated cost of reducing highway diesel fuel sulfur from 20 ppm to 2 ppm ranges from 1.7 to 2.1 cents per gallon. Assuming a linear relationship between sulfur and cost per gallon in this range, the cost of reducing average sulfur levels from 7 ppm (that projected under the proposed 15 ppm cap) to 2 ppm would be 0.7–0.8 cents per gallon. Although it is possible that the cost per ppm of sulfur reduced would actually increase as sulfur was reduced, the extent of this increase is difficult to estimate. Thus, the best cost that we can project at this time is 0.7–0.8 cents per gallon, incremental to the cost of the 15 ppm sulfur cap program.

Although we have not attempted to analyze in detail the cost impacts of distributing a fuel with a cap on sulfur content as low as 5 ppm, the American Petroleum Institute recently had a contractor do so.[158] That study estimated that, compared to current costs, distribution costs would increase by 0.9 to 2.1 cents per gallon if a 5 ppm standard were adopted for the entire highway diesel pool.[159] The following reasons were cited for why, as the sulfur specification is decreased, it becomes more difficult to maintain product purity and supply:

—There is increased difficulty and cost associated with correcting off-specification batches in the distribution system.
—Measurement accuracy becomes more limiting.
—The pipeline compliance margin becomes more limiting at refineries.
—Supply outages due to off-specification product will become more common.
—The difference between the sulfur content of highway diesel fuel and that of abutting higher sulfur products in the pipeline system becomes larger.

Even with the estimated increase in distribution costs, the report still concluded that it was probably impractical to attain continuous supply availability of diesel fuel in all areas and outlets within the current distribution system at a 5 ppm cap on fuel sulfur content. If such problems are to be avoided, additional, more costly measures may be necessary. Should a segregated distribution system be needed to control contamination, including dedicated pipelines and tank trucks, the costs would be considerably higher than the 0.9 to 2.1 cents per gallon estimated in the report.

We too are concerned that the measures which form the basis for the 0.9 to 2.1 cents per gallon cost estimate in the API-sponsored study may not ensure widespread compliance. Under a 5 ppm standard, sulfur measurement variability would need to be reduced appreciably from current tolerances, perhaps to a level of 1 ppm or less, and the test equipment purchases and quality control steps needed to attain this could prove costly. Yet the bulk of the impact would come from the major shift likely to be needed in the practices used to avoid contamination in the distribution system. Assuming an extremely demanding maximum sulfur specification of 3 ppm at the refinery gate and a test variability of 1 ppm, only 1 ppm contamination through the distribution system could be tolerated, and this would need to be maintained nationwide and year round in a distribution system that routinely handles products with sulfur levels of up to several thousand ppm. Refiners would also need to take additional measures to meet the 3 ppm refinery gate standard that would likely be set by pipeline operators. Similar to the distribution system, the measures that refiners would need to take to further reduce sulfur content and limit process variability are unclear, and might prove quite costly.

The overall cost of a program with a 5 ppm sulfur cap is comprised of the program's cost in producing and distributing the fuel, offset by the cost of the projected 1 percent fuel economy gain. As the sulfur level reaches this very low level, the types of process changes in the refinery and fuel distribution systems necessary to eliminate contamination and maintain sufficient process flexibility in the system become much more uncertain. Consequently, serious concerns have

[158] "Costs/Impacts of Distributing Potential Ultra Low Sulfur Diesel, Turner, Mason, & Company Consulting Engineers," February 2000. EPA Docket A–99–06, item II–G–49.

[159] "Costs/Impacts of Distributing Potential Ultra Low Sulfur Diesel, Turner, Mason, & Company Consulting Engineers," February 2000. EPA Docket A–99–06, item II–G–49.

been raised concerning the ability to achieve a 5 ppm sulfur cap without drastic and costly changes to how diesel fuel is produced and distributed today. Nevertheless, assuming the average of the per gallon production and distribution cost ranges discussed above, this corresponds to a net $47.1 billion 30-year NPV cost, compared to $37.7 billion for the 15 ppm sulfur cap proposal. Considering the NO_X emissions benefits (unchanged from the 15 ppm sulfur cap case) and the PM emissions benefits (slightly improved), the resulting aggregate cost effectiveness is projected to be $1900 per ton of NO_X+NMHC and $4500 per ton of PM (including the SO_2 credit). These compare to $1500 per ton of NO_X+NMHC and $1900 per ton of PM for the 15 ppm sulfur cap proposal.

3. What About a 50 ppm Sulfur Level?

The American Petroleum Institute has proposed that we set a sulfur cap for highway diesel fuel of 50 ppm with a required refinery output average of 30 ppm, along with other proposal elements.[160] API's proposal is based on their assessment of technological need and viability. Key to API's position is the view that, ''while EPA may set standards to encourage advanced technology, EPA must not base a sulfur level on a particular technology the Agency predicts might prove viable.'' However, we believe that we must set standards in the context of real technologies that can be expected to be feasible, rather than as a means of generally encouraging advanced technology. With this in mind, we have analyzed the impact that a 50 ppm sulfur cap would have on technology enablement, vehicle and fuel costs, and emissions reductions. The results of this analysis are provided below. Analysis details are provided in the Draft RIA. We encourage comment on this assessment, preferably accompanied by data and analysis supporting the commenter's views.

As discussed in detail in section III.F, we believe that diesel fuel needs to be desulfurized to the 15 ppm level to enable emission control technologies capable of meeting the proposed standards. Setting a fuel sulfur cap of 50 ppm would require that the PM standard be set at a less stringent level to accommodate the approximate tripling of sulfate PM production in the trap compared to a 15 ppm cap. However, we believe increased fuel sulfur would have an even larger effect on robust trap regeneration than on sulfate production, bringing into question the very viability of PM traps at the higher sulfur levels. As discussed in section III.F.1, field experience in Sweden, where below 10 ppm diesel fuel sulfur is readily available, has been good. Experience has also been good in regions without extended periods of cold ambient conditions (such as the United Kingdom) using 50 ppm cap low sulfur fuel. However, field tests in Finland, where colder winter conditions are sometimes encountered (similar to many parts of the United States), have revealed a failure rate of 10 percent, due to insufficient trap regeneration. We believe that failures of the severity experienced with 50 ppm fuel in Finland would be unacceptable. These problems could become even more pronounced in light-duty applications, which tend to involve cooler exhaust streams, making regeneration more difficult. Field data with such applications is still sparse.

One means of attempting to resolve these problems is through use of an active regeneration mechanism, such as electric heaters or fuel burners. These could potentially introduce additional hardware and fuel consumption costs. They would also raise reliability concerns, based on past experience with such approaches. Active regeneration failures in PM traps would be of more concern than in NO_X exhaust emission control devices because they involve the potential for complete exhaust stream plugging, runaway regeneration at very high temperatures, trap melting, engine stalling, and stranding of motorists in severe weather. As a result, we do not consider dependence on active PM trap regeneration to be a sufficient basis for establishing PM trap feasibility.

NO_X adsorber technology would likely be infeasible with 50 ppm sulfur fuel as well, due to the rapid poisoning of NO_X storage sites. Desulfation would be needed much more frequently and with a much higher resulting fuel consumption. Even if the fuel economy penalty could somehow be justified, we expect that overly frequent desulfation could cause unacceptable adsorber durability or driveability problems (because of the difficulty in timing the desulfation to avoid driving modes in which it might be noticed by the driver). A less stringent NO_X standard could help to mitigate these concerns by allowing the NO_X storage bed to sulfate up to a greater degree before desulfating. However, this might then cause deeper sulfate penetration into the storage bed and thus possible long-term degradation because of the difficulty of removing this deeper sulfate.

Instead, we expect that diesel fuel with an average fuel sulfur level of 30 ppm and a cap of 50 ppm could enable lean NO_X catalyst technology (described in section III.E). These devices can provide modest NO_X reductions and, because of their reliance on precious metal catalyst, also serve the function of a diesel oxidation catalyst, removing some of the gaseous hydrocarbons and the soluble organic fraction of PM. Unfortunately, lean NO_X catalysts also share the oxidation catalyst's tendency to convert fuel sulfur into sulfate PM, and do so even more aggressively because they require higher precious metal loadings to reduce NO_X. They also require a fairly large addition of diesel fuel to accomplish NO_X reduction, typically about 4 percent or more of total fuel consumption. The injected fuel also makes it difficult to achieve an overall hydrocarbon reduction, despite the potential to convert much of the engine-out hydrocarbons over the catalyst. Typically, current lean NO_X catalyst designs actually show a net hydrocarbon increase.

We have assumed that lean NO_X catalysts could be developed over time to deliver 20 percent reductions in NO_X (well beyond their current proven performance over the Federal Test Procedure) with a net PM reduction of 20 percent and no net increase in gaseous hydrocarbons with a 4 percent fuel economy penalty. Although this PM reduction level is below that achieved by current diesel oxidation catalysts, it represents an ambitious target to designers attempting to balance NO_X reduction with sulfate production from the still substantial sulfur in the fuel. We have estimated that lean NO_X catalysts (including their diesel oxidation catalyst function) would add an average long term cost of $603 to a heavy-duty vehicle, inclusive of maintenance savings realized through the use of low sulfur fuel. This is lower than the cost increase for technologies enabled by 15 ppm sulfur fuel.

Based on the 20% expected emission reductions, we believe the appropriate emissions standards at a 30 ppm average / 50 ppm cap diesel sulfur level would be 1.8 g/bhp-hr NO_X and 0.08 g/hp-hr PM. Because the enabled technologies do not allow very large emission reductions and stringent emission standards, it is conceivable that continued progress in engine design may eventually allow these standards to be met through improvements in EGR and combustion optimization, although we cannot outline such a technology path at this time. It is likely that such a path would still involve a substantial fuel economy penalty.

[160] Letter from Red Cavaney of API to EPA Administrator Carol Browner, dated February 7, 2000, EPA docket A–99–06.

The 50 ppm sulfur cap would therefore result in projected NO_X and PM emission reductions in 2020 of 540,000 and 17,000 tons per year, respectively, compared to 2.0 million and 83,000 tons per year for a 15 ppm cap. It should be noted that virtually none of the PM reduction comes from a reduction in the soot component of PM.

The cost of meeting a 50 ppm sulfur cap at the refinery would be substantially less costly than meeting the proposed cap of 15 ppm. In some cases, refiners may be able to meet a 50 ppm cap with only relatively minor capital investment of a few million dollars for a new hydrogen sulfide scrubbing unit and a PSA unit to increase hydrogen purity. New, high activity catalyst would also replace today's catalyst. In other cases, refiners would also have to add a second reactor. Finally, some refiners would require essentially the same two-stage hydrotreating unit that would be required to meet the proposed 15 ppm standard. In all cases, hydrogen consumption would be somewhat less than that required to meet the proposed 15 ppm standard.

Refiners who would be capable of meeting a 50 ppm cap with only minor capital investment would likely be those not blending any LCO into their diesel fuel, or those having substantial excess hydrotreating capacity in their current unit. We estimate that about 15 percent of on-highway diesel fuel production would fall into this category. Refiners blending some LCO into their diesel fuel (e.g., 15 percent or less), or with somewhat greater levels of LCO but also having significant excess current hydrotreating capacity, would likely be capable of meeting a 50 ppm cap with an additional reactor. We estimate that about 35 percent of on-highway diesel fuel production would fall into this category. Finally, about 50 percent of on-highway diesel fuel production would likely require a two-stage hydrotreating unit due to their higher LCO fraction or lack of excess current hydrotreating capacity. Overall, we project that the average cost of meeting the 50 ppm standard at the refinery would be about 2.3 cents per gallon, about 1.7 cents per gallon less than the corresponding cost for fuel meeting a 15 ppm sulfur cap.

It would be slightly less expensive to distribute the 50 ppm sulfur fuel than the15 ppm sulfur fuel. The pipeline interface between highway diesel fuel and higher sulfur products that must be sold with the higher sulfur product to ensure quality of the highway diesel fuel could be reduced. We estimate the cost savings per gallon of diesel fuel to be about 0.01 cents.

The overall cost of a program with a 50 ppm sulfur cap with a 30 ppm average is comprised of the hardware cost of lean NO_X catalyst technology, the cost increase in producing and distributing the fuel, and the cost of the projected 4% fuel economy loss. This corresponds to a net $35.4 billion 30-year NPV cost, compared to $37.7 billion for the 15 ppm sulfur cap proposal. Considering the PM and NO_X emissions benefits, the resulting aggregate cost effectiveness is projected to be $3600 per ton of NO_X+NMHC and $56,700 per ton of PM (including the SO_2 credit). These compare to $1500 per ton of NO_X+NMHC and $1900 per ton of PM for the 15 ppm sulfur cap proposal. The large difference in PM cost effectiveness is primarily due to the fuel economy penalty and the fact that none of the fuel cost could be allocated to hydrocarbon control, because of the lack of a hydrocarbon benefit.

Table VI.B–5 summarizes key emissions and cost impacts of a program adopting the sulfur levels analyzed. Note that, although the analysis finds that a 15 ppm average/25 ppm cap standard has potential to be adequate for enabling high-efficiency exhaust emissions controls, this finding involves a significantly higher level of uncertainty than the proposed 15 ppm sulfur cap, because it is based on the assumption that exhaust emission control designs could be focused on the average fuel sulfur levels. We believe that the possibility of some in-use fuel at near-cap levels would necessitate designing to accommodate this level, and they contend that this would not allow the high-efficiency technology to be enabled. If so, the technology enablement for this case would likely be similar to that for the 50 ppm cap case. The analysis results show that the 50 ppm cap case does not enable high-efficiency exhaust control technology at all.

TABLE VI.B–5.—SUMMARY OF EMISSIONS AND COST IMPACTS AT DIFFERENT FUEL SULFUR LEVELS

Sulfur level	2020 emission reductions (thousand tons/year)		Cost impacts			
	NO_X	PM	Vehicle [c]	Fuel consumption (percent)	Fuel (¢/gal)	Aggregate 30-yr NPV ($ billion)
5 ppm cap	2,020	86	$1,133	–1	[d] 6.0–7.3	[d] 47.1
15 ppm cap	2,020	83	1,133	0	4.4	37.7
25 ppm cap w/15 ppm average [a]	2,020	79	1,133	1	3.4	34.5
50 ppm cap w/30 ppm average [b]	538	17	603	4	2.7	35.4

[a] Note that this sulfur level involves significant increased uncertainty with respect to technology enablement. Manufacturers have commented that the possibility of some in-use fuel at or near the 25 ppm cap level would necessitate designing to accommodate this level, thus precluding high-efficiency technology enablement, and making technology for this case similar to that for the 50 ppm cap case.

[b] This sulfur level is not expected to enable high-efficiency exhaust control technology.

[c] Costs of added hardware combined with lifetime maintenance cost impacts; figures shown for comparison purposes are long-term costs for heavy heavy-duty vehicles.

[d] Fuel cost based on industry analyses of refinery and distribution costs; costs could range much higher depending on fuel segregation measures required.

We welcome comments on all aspects of these analyses for alternative fuel sulfur standards, including the technology enablement assessments, vehicle and fuel costs, emissions reductions, and cost effectiveness.

4. What Other Fuel Properties Were Considered for Highway Diesel Fuel?

In addition to changes in highway diesel fuel sulfur content, we also considered changes to other fuel properties such as cetane number, aromatics, density, or distillation. Each of these fuel properties has the potential to affect the combustion chemistry within the engine, and so aid in reducing emissions of regulated pollutants. Indeed, some manufacturers have made public statements to the effect that an idealized highway diesel fuel is necessary in order to optimize the efficiency of the next generation of heavy-duty diesel vehicles.

The focus of the fuel changes we are proposing today is to enable diesel engines to meet much more stringent emission standards. As described earlier in this section, we believe that diesel engines can meet much more stringent emission standards using advanced exhaust emission control systems, but the performance of these systems is dramatically reduced by sulfur. Thus, we have determined that sulfur in diesel fuel would need to be lowered. It does not appear that other fuel properties have the same sort of effect on advanced exhaust emission controls, and as a result we do not believe that changes in fuel properties other than sulfur are necessary in order for heavy-duty engines to reach the low emission levels offered by the advanced exhaust emission controls discussed above. In fact, after conducting a research study on this topic, industry members concluded that, ''If in the future, fuel sulfur levels are significantly reduced in order to enable efficient exhaust emission controls, then it should be recognized that the exhaust emission control device becomes the primary driver on tailpipe emissions and that all other fuel properties will have only minor or secondary effects on the tailpipe emissions.'' [161]

Emission reductions can also be achieved through changes in diesel fuel properties as a direct means for reducing engine-out emissions. In this approach, it is not the exhaust emission control which is being ''enabled,'' but rather the combustion process itself which is being optimized. This approach has the advantage that the effects are fleet-wide and immediate upon introduction of the new fuel, whereas new engine standards do not produce significant emission reductions until the fleet turns over. However, regulated changes in diesel fuel properties may produce emission reductions that disappear over time, if compliance test fuel is changed concurrently with the changes to in-use fuel (to assure that such fuel remains representative of in-use fuels). Manufacturers will redesign their new engines to take advantage of any benefit a cleaner fuel provides, resulting in engines still meeting the same emission standards in-use. Consequently, it would only be those engines sold before the compliance test fuel changes that would be likely to produce emission benefits, and as these engines drop out of the fleet, so also would the benefit of changes to diesel fuel.

[161] Lee, et al., SAE 982649.

Even so, it is useful to consider what emission reductions are achievable through changes to non-sulfur diesel fuel properties. The non-sulfur fuel properties most often touted as good candidates for producing emission reductions from heavy-duty engines are cetane number and aromatics content. According to correlations between these fuel properties and emissions that have been presented in various published documents, the effects are rather small. We have estimated that an increase in cetane number from 44 to 50 would reduce both NO_X and PM emissions by about 1 percent for the in-use fleet in calender year 2004.[162] Likewise a reduction in total aromatics content from 34 volume percent to 20 volume percent would reduce both NO_X and PM emissions by about 3 percent. We expect changes in other fuel properties to produce emission reductions that are no greater than these effects. These reductions are insignificant in comparison to the emission benefits projected to result from today's proposal, and would come at a considerable refining cost. As a result, at this time we do not believe that it is appropriate to require changes to non-sulfur diesel fuel properties as a means for producing reductions in engine-out emissions. There may, however, be performance or engine design optimization benefits associated with non-sulfur changes to diesel fuel that could justify their cost. Therefore we welcome cross-industry collaboration on voluntary diesel fuel improvements beyond the sulfur reduction proposed in this notice, and we continue to solicit information on the impact of non-sulfur fuel changes on exhaust emission control, engine-out emissions, and engine design and performance.

C. Should Any States or Territories Be Excluded From This Rule?

1. What Are the Anticipated Impacts of Using High-Sulfur Fuel in New and Emerging Diesel Engine Technologies if Areas Are Excluded From This Rule?

Section III discusses the technological feasibility of the emission standards being proposed today and the critical need to have sulfur levels reduced to 15 ppm for the technology to achieve these emission standards. The implications to be drawn from section III with regard to exemptions from the sulfur standards for States and Territories is fairly straightforward. If vehicles and engines employing these technologies to achieve the proposed emission standards will be operated in these states or territories, then low-sulfur diesel fuel must be available for their use.

[162] ''Exhaust emissions as a function of fuel properties for diesel-powered heavy-duty engines,'' memorandum from David Korotney to EPA Air Docket A–99–06, September 13, 1999.

Some have suggested allowing persons in Alaska to remove emission control equipment to enhance the viability of using high-sulfur fuel. In addressing this issue, we note that, under the Clean Air Act, it is prohibited in all 50 states to remove emission control equipment from an engine, unless that equipment is damaged or not properly functioning, and then is replaced with equivalent properly functioning equipment.

2. Alaska

a. Why is Alaska Unique?

There are important nationwide environmental and public health benefits that can be achieved with cleaner diesel engines and fuel, particularly from reduced particulate emissions, nitrogen oxides, and air toxics (as further discussed in section II). Therefore, it is also important to implement this program in Alaska. Any 2007 and later model year diesel vehicles in Alaska would have to be fueled with low sulfur highway diesel, or risk potential damage to the aftertreatment technologies or even the engines themselves. Although the engine standards proposed today do not have different technology and cost implications for Alaska as compared to the rest of the country, the low sulfur fuel program would have different implications (described below). Therefore, in evaluating the best approach for implementing the low sulfur fuel program, it is important to consider the extremely unique factors in Alaska.

Section 211(i)(4) provides that the states of Alaska and Hawaii may seek an exemption from the 500 ppm sulfur standard in the same manner as provided in section 325 of the Clean Air Act. Section 325 provides that upon request of Guam, American Samoa, the Virgin Islands, or the Commonwealth of the Northern Mariana Islands, EPA may exempt any person or source, or class of persons or sources, in that territory from any requirement of the CAA, with some specific exceptions. The requested exemption could be granted if EPA determines that compliance with such requirement is not feasible or is unreasonable due to unique geographical, meteorological, or economic factors of the territory, or other local factors as EPA considers significant.

Unlike the rest of the nation, Alaska is currently exempt from the 500 ppm sulfur standard for highway diesel fuel (as discussed in section c below). Since the beginning of the 500 ppm highway diesel fuel program, we have granted Alaska exemptions from meeting the sulfur standard and dye requirements, because of its unique geographical, meteorological, air quality, and economic factors. These unique factors are described in more detail in the Draft Regulatory Impact Analysis contained in the docket.

Second, in Alaska, unlike in the rest of the country, diesel fuel consumption for highway use represents only five percent of the State's total distillate fuel consumption, because of the relatively small numbers of vehicles in the State. Most of this fuel is produced by refineries located in Alaska, primarily because of the more severe cloud point specification needed for the extremely low temperatures experienced in much of Alaska during the winter. There are four commercial refineries in Alaska. Only one of these refineries currently has any desulfurization capacity, which is relatively small. Consequently, because these refineries would have to reduce sulfur from uncontrolled levels to meet the proposed 15 ppm standard, these refineries could incur substantially higher costs than those in the rest of the nation. Given the very small highway diesel demand, however, it is doubtful that more than one or two Alaska refineries would choose to produce low sulfur highway fuel, and these refiners could even decide to import it from refineries outside of Alaska.

Third, Alaska's highway diesel vehicle fleet is relatively small, particularly outside the Federal Aid Highway System. The State estimates that there are less than 9000 diesel vehicles in the entire State, with less than 600 of these vehicles in all of rural Alaska. The State also indicates that these vehicles are predominantly older than the average elsewhere.[163]

Finally, Alaska's fuel distribution system faces many unique challenges. Unlike the rest of the country, because of its current exemption from the 500 ppm sulfur standard, Alaska does not currently segregate highway diesel fuel from that used for off-road, marine, heating oil, and other distillate uses. Therefore, the distribution system costs for segregating a low sulfur grade of diesel for highway uses will be significant. The existing fuel storage facilities limit the number of fuel types that can be stored. In addition to significant obstacles to expanding tankage in Alaska, the cost of constructing separate storage facilities, and providing separate tanks for transporting low-sulfur diesel fuel (e.g., by barge or truck), could be significant. Most of Alaska's communities rely on barge deliveries, and ice formation on the navigable waters during the winter months restricts fuel delivery to these areas. Construction costs are 30 percent higher in Alaska than in the lower-48 states, due to higher costs for freight deliveries, materials, electrical, mechanical, and labor. There is also a shorter period of time during which construction can occur, because of seasonal extremes in temperature and the amount of daily sunlight.

b. What Flexibilities Are We Proposing for Alaska?

Because of the unique circumstances in Alaska, we are proposing an alternative option for implementing the low sulfur fuel program in Alaska. We are proposing to provide the State an opportunity to develop an alternative low sulfur transition plan for Alaska. We would intend to facilitate the development of this plan by working in close cooperation with the State and key stakeholders. This plan would need to ensure that sufficient supplies of low sulfur diesel fuel are available in Alaska to meet the demand of any new 2007 and later model year diesel vehicles. Given that Alaska's demand for highway diesel fuel is very low and only a small number of new diesel vehicles are introduced each year, it may be possible to develop an alternative implementation plan for Alaska in the early years of the program that provides low sulfur diesel only in sufficient quantities to meet the demand from the small number of new diesel vehicles. This would give Alaska refiners more flexibility during the transition period because they would not have to desulfurize the entire highway diesel volume. Our goal in offering this additional flexibility would be to transition Alaska into the low sulfur fuel program in a manner that minimizes costs, while still ensuring that the new vehicles receive the low sulfur fuel they need. We expect that the transition plan would begin to be implemented at the same time as the national program, but the State would have an opportunity to determine what volumes of low sulfur fuel would need to supplied, and in what timeframes, in different areas of the State.

At a minimum, such a transition plan would need to: (1) Ensure an adequate supply (either through production or imports), (2) ensure sufficient retail availability of low sulfur fuel for new vehicles in Alaska, (3) address the growth of supply and availability over time as more new vehicles enter the fleet, (4) include measures to prevent misfueling, and (5) ensure enforceability. We would anticipate that, to develop a workable transition plan, the State would likely work in close cooperation with refiners and other key stakeholders, including retailers, distributors, truckers, engine manufacturers, environmental groups, and other interested groups. For example, the State would likely rely on input from the trucking industry in determining the expected low sulfur fuel volume needed in Alaska, based on the anticipated number of new vehicles, and how this volume is expected to grow during the first few years of the program. Similarly, the State would likely rely on the Alaska refiners' input regarding plans for supplying (either through production or imports) low sulfur fuel to meet the expected demand. Further, the State would likely rely on input and cooperation from retailers and distributors to determine at which locations the low sulfur fuel should be made available. Retailers offering low sulfur fuel would have to take measures to prevent misfueling, such as pump labeling. All parties in the distribution system would need to ensure the low sulfur fuel remains segregated and take measures to prevent sulfur contamination, in the same manner as described for the national program in section VIII.

If the State anticipates that the primary demand for low sulfur fuel will be along the highway system (*e.g.*, to address truck traffic from the lower 48 states) in the early years of the program, then the initial stages of the transition plan could be focused in these areas. We believe it would be appropriate for the State to consider an extended transition schedule for implementing the low sulfur program in rural Alaska, as part of the state's overall plan, based on when they anticipate the introduction of a significant number of 2007 and later model year vehicles in the remote areas.

Under such an approach, the State would be given the opportunity to develop such a transition plan, as an alternative to the national program, and submit it to EPA. Our goal would be to help facilitate the development of the plan, by working closely with the State and the stakeholder group so they would have an opportunity to address EPA's concerns in their submittal. We envision that the State would develop and submit this plan to EPA within about one year of the final diesel rule. Our goal would be to conduct a rulemaking and publish a final rule

[163] See further discussion in the Draft RIA (Chapter VIII).

promulgating a new regulatory scheme for Alaska, if appropriate. The goal would be to issue a final rule within one year of Alaska's submittal of the plan, so that refiners and other affected parties would have certainty as to their regulatory requirements. We request comment on the timing for the State to submit such an alternative plan, and for EPA to conduct the rulemaking action. If the State chose not to submit an alternative plan, or if the plan did not provide a reasonable alternative for Alaska as described above, then Alaska would be subject to the national program.

We seek comment on all aspects of this approach, and on other approaches that may have merit, to provide additional flexibility in transitioning the low sulfur fuel program for Alaska.

c. How Do We Propose to Address Alaska's Petition Regarding the 500 ppm Standard?

Background

On February 12, 1993, Alaska submitted a petition under section 325 of the Act to exempt highway vehicle diesel fuel in Alaska from paragraphs (1) and (2) of section 211(i) of the Act, except for the minimum cetane index requirement.[164] The petition requested that we temporarily exempt highway vehicle diesel fuel in communities served by the Federal Aid Highway System from meeting the sulfur content specified in section 211(i) of the Act and the dye requirement for non-highway diesel fuel of 40 CFR 80.29, until October 1, 1996. The petition also requested a permanent exemption from those requirements for areas of Alaska not reachable by the Federal Aid Highway System—the remote areas. On March 22, 1994, (59 FR 13610), we granted the petition based on geographical, meteorological, air quality, and economic factors unique to Alaska.

On December 12, 1995, Alaska submitted a petition for a permanent exemption for all areas of the State served by the Federal Aid Highway System, that is, those areas covered only by the temporary exemption. On August 19, 1996, we extended the temporary exemption until October 1, 1998 (61 FR 42812), to give us time to consider comments to that petition that were subsequently submitted by stakeholders. On April 28, 1998 (63 FR 23241) we proposed to grant the petition for permanent exemption. Substantial public comments and substantive new information were submitted in response to the proposal. To give us time to consider those comments and new information, we extended the temporary exemption for another nine months until July 1, 1999 (September 16, 1998, 63 FR 49459). During this time period, we started work on a nationwide rule to consider more stringent diesel fuel requirements, particularly for the sulfur content (i.e., today's proposed rule). To coordinate the decision on Alaska's request for a permanent exemption with this nationwide rule on diesel fuel quality, we extended the temporary exemption until January 1, 2004 (June 25, 1999 64 FR 34126).

Today's Proposed Action

As mentioned above, Alaska has submitted a petition for a permanent exemption from the 500 ppm standard for areas not served by the Federal Aid Highway System. Our goal is to take action on this petition in a way that minimizes costs through Alaska's transition to the low sulfur program. The cost of compliance could be reduced if Alaska refiners were given the flexibility to meet the low sulfur standard in one step, rather than two steps (i.e., once for the current 500 ppm sulfur standard in 2004 when the temporary exemption expires, and again for the proposed 15 ppm standard in 2006). Therefore, we propose to extend the temporary exemption for the areas of Alaska served by the Federal Aid Highway System from January 1, 2004 (the current expiration date) to the proposed effective date for the proposed 15 ppm sulfur standard (i.e., April 1, 2006 at the refinery level; May 1, 2006 at the terminal level; and June 1, 2006 at all downstream locations).

As discussed in section b above, we are proposing to allow Alaska to develop a transition plan for implementing the 15 ppm sulfur program. During this transition period, it is possible that both 15 ppm (for proposed 2007 and later model year vehicles) and higher sulfur (for older vehicles) highway fuels might be available in Alaska. To avoid the two-step sulfur program described above, we seek comment on whether we should consider additional extensions to the temporary exemption of the 500 ppm standard beyond 2006 (e.g., for that portion of the highway pool that is available for the older technology vehicles during Alaska's transition period). We would expect that any additional temporary extensions, if appropriate, would be made in the context of the separate rulemaking taking action on Alaska's transition plan (as described in the previous section).

As in previous actions to grant Alaska sulfur exemptions, we would not base any vehicle or engine recall on emissions exceedences caused by the use of high-sulfur (>500 ppm) fuel in Alaska during the period of the temporary sulfur exemption. In addition, manufacturers may have a reasonable basis for denying emission related warranties where damage or failures are caused by the use of high-sulfur (>500 ppm) fuel in Alaska.

Finally, the costs of complying could be reduced significantly if Alaska were not required to dye the non-highway fuel. Dye contamination of other fuels, particularly jet fuel, is a serious potential problem. This is a serious issue in Alaska since the same transport and storage tanks used for jet fuel are generally also used for other diesel products, including off-highway diesel products which are required to be dyed under the current national program. This issue is discussed further in the Draft RIA (Chapter VIII). Therefore, we also propose to grant Alaska's request for a permanent exemption from the dye requirement of 40 CFR 80.29 and 40 CFR 80.446 for the entire State.

We are interested in comments on all aspects of this proposal.

3. American Samoa, Guam, and the Commonwealth of Northern Mariana Islands

a. Why Are We Considering Excluding American Samoa, Guam, and the Commonwealth of Northern Mariana Islands?

Prior to the effective date of the current highway diesel sulfur standard of 500 ppm, the territories of American Samoa, Guam and the Commonwealth of Northern Mariana Islands (CNMI) petitioned EPA for an exemption under section 325 of the Act from the sulfur requirement under section 211(i) of the Act and associated regulations at 40 CFR 80.29. The petitions were based on geographical, meteorological, air quality, and economic factors unique to those territories. We subsequently granted the petitions.[165] With today's proposal we need to evaluate whether to include or exclude the territories in areas for which the fuel sulfur standard would apply.

b. What are the Relevant Factors?

The key relevant factors unique to these territories, briefly discussed below, are discussed in detail in the

[164] Copies of information regarding Alaska's petition for exemption and subsequent requests by Alaska and actions by EPA are available in public docket A–96–26.

[165] See 57 FR 32010, July 20, 1992 for American Samoa; 57 FR 32010, July 30, 1992 for Guam; and 59 FR 26129, May 19, 1994 for CNMI.

Draft RIA. These U.S. Territories are islands with limited transportation networks. Consequently among these three territories there are currently only approximately 1300 registered diesel vehicles. Diesel fuel consumption in these vehicles represents just a tiny fraction of the total diesel fuel volume consumed in these places; the bulk of diesel fuel is burned in marine, nonroad, and stationary applications. Consequently highway diesel vehicles are believed to have a negligible impact on the air quality in these territories, which, with minor exceptions, is very good.

All three of these territories lack internal petroleum supplies and refining capabilities and rely on long distance imports. Given their remote location from the U.S. mainland, petroleum products are imported from east rim nations, particularly Singapore. Although Australia, the Philippines, and certain other Asian countries have or will soon require low-sulfur diesel fuel, this requirement is a 500 ppm sulfur limit, not the proposed 15 ppm sulfur limit. Compliance with low-sulfur requirements for highway fuel would require construction of separate storage and handling facilities for a unique grade of diesel fuel for highway purposes, or importation of low-sulfur diesel fuel for all purposes, either of which would significantly add to the already high cost of diesel fuel in territories which rely heavily on United States support for their economies.

c. What Are the Options and Proposed Provisions for the Territories?

We could include or exclude the territories in the areas for which the proposed diesel fuel sulfur standard would apply. As in the early 1990's when the 500 ppm sulfur standard was implemented, we believe that compliance with the proposed 15 ppm sulfur standard would result in relatively small environmental benefit, but major economic burden. We are also concerned about the impact to vehicle owners and operators of running the new and upcoming engine and emission control technologies using high-sulfur fuel. We believe that for the sulfur exemption to be viable for vehicle owners and operators, they would need access to either low-sulfur fuel or vehicles meeting the pre-2007 HDV emission standards that could be run on high-sulfur fuel without significant engine damage or performance degradation.

We are proposing to exclude American Samoa, Guam and CNMI from the proposed diesel fuel sulfur requirement of 15 ppm because of the high economic cost of compliance and minimal air quality benefits. We are also proposing to exclude, but not prohibit, the territories from the 2007 heavy-duty diesel vehicle and engine emissions standards, and other requirements associated with those emission standards based on the increased costs associated with implementing the vehicle and fuel standards together in these territories. Thus, the territories would continue to have access to 2006 diesel vehicle and engine technologies. This exclusion from standards would not apply to gasoline engines and vehicles because gasoline that complies with our regulations will be available, and so concerns about damage to engines and emissions control systems will not exist. As proposed this exclusion from standards does not apply to light-duty diesel vehicles and trucks because gasoline vehicles meeting the emission standards and capable of fulfilling the same function would be available.

We are proposing to continue requiring all diesel motor vehicles and engines to be certified and labeled to the applicable requirements (either to the 2006 model year standards and associated requirements, or to the standards and associated requirements applicable for the model year of production) and warranted, as otherwise required under the Clean Air Act and EPA regulations. Special recall and warranty considerations due to the use of exempted high-sulfur fuel are proposed to be the same as those proposed for Alaska during its proposed transition period. To protect against this exclusion being used to circumvent the emission requirements applicable to the rest of the United States (i.e., continental United States, Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands) after 2006 by routing pre-2007 technology vehicles and engines through one of these territories, we propose to restrict the importation of vehicles and engines from these territories into the rest of the United States. After the 2006 model year, diesel vehicles and engines certified under this exclusion to meet the 2006 model year emission standards for sale in American Samoa, Guam and CNMI would not be permitted entry into the rest of the United States.

We request comment on these exclusions and particularly on whether it should be extended to light-duty diesel vehicle and truck standards as well.

D. What About the Use of JP–8 Fuel in Diesel-Equipped Military Vehicles?

In 1995, EPA issued a letter to the Deputy Under Secretary of Defense for Environmental Security which concluded that the military specification fuel known as JP–8 did not meet the definition of diesel fuel under EPA's regulations and was, therefore, not subject to the 0.05 percent by weight sulfur standard. EPA also determined that despite the slightly higher sulfur levels, the use of JP–8 in motor vehicles by the military would not be a violation of EPA regulations as a matter of policy. This decision was made after careful consideration of the impact on operational readiness, logistical considerations and cost for the military. EPA also evaluated data presented by the military which compared the emissions of vehicles operated on typical highway diesel and JP–8. These data supported the conclusion that there would not be a significant adverse environmental consequence from the limited use of JP–8 fuel. EPA's evaluation of the emissions impact was, of course, based on the results of tests conducted using vehicles representative of diesel emission control technology and diesel fuel in use at that time.

The technical basis for EPA's decision on this matter may be affected by the prospect of military vehicles equipped with the highly sulfur sensitive technology that is expected to be used on vehicles and engines designed to meet the standards for 2007 and beyond. We request comment from interested parties on how to best deal with this situation, including comment on the extent to which national security exemptions pursued under 40 CFR 85.1708 may affect resolution of the issue.

VII. Requirements for Engine and Vehicle Manufacturers

A. Compliance With Standards and Enforcement

We are not proposing any changes to the enforcement scheme currently applicable to vehicles and engines under Title II of the CAA. Thus, they would continue to apply to the vehicles and engines subject to today's proposed standards. This includes the enforcement provisions relating to the manufacture, importation and in-use compliance of these vehicles and engines (see sections 202–208 of the CAA). Manufacturers are required to obtain a certificate of conformity for their engine designs prior to introducing them into commerce, and are subject to Selective Enforcement Audits during production. Although there are currently no regulatory requirements for manufacturers to test in-use engines, they are responsible for the emission performance of their engines in use. If we determine that a substantial number of properly maintained and used engines in any engine family is not complying with the standards in use, then we may require the manufacturer to recall the engines and remedy the noncompliance. Failure by a manufacturer to comply with the certification, warranty, reporting, and other requirements of Title II can result in sanctions including civil penalties and injunctive relief (see sections 202–208 of the CAA). Other enforcement provisions regulating persons in addition to manufacturers would also be applicable to the affected diesel vehicles, including provisions such as the tampering and defeat device prohibitions. It is also important to note that, because the CAA defines manufacturer to include importers, all of these requirements and prohibitions apply equally to importers.

Consideration has been given to in-use issues that may arise from use of the new exhaust emission control technology. While it is believed that the technology is sufficient to ensure that emission control devices and elements of design will be effective throughout the useful life of the vehicle, some concern has been expressed regarding the possibility that instances of driveability or other operational problems could occur in-use. One example brought up, is the possibility that a vehicle could experience severe driveability problems if the PM trap becomes plugged. At this time, however, we are confident that the technologies will be developed to prevent these types of problems from occurring provided the vehicle is operated on the appropriate fuel. Nevertheless, comments are requested on any in-use problems that may arise as a result of inclusion of exhaust emission control technology. Your comments should address the nature of the problem, likelihood of its occurrence and options for ensuring it does not occur.

Another issue related to certification is what (if any) maintenance we should allow for adsorbers and traps. Our existing regulations define these to be critical emission-related components, which means that the amount of maintenance of them that the manufacturer is allowed to conduct during durability testing (or specify in the maintenance instructions that it gives to operators) is limited. We believe that this is appropriate because, as we already noted, we expect that these technologies will be very durable in use and will last the full useful life with little or no scheduled maintenance. However, our existing regulations (40 CFR 86.004–25) would allow a manufacturer to specify something as drastic as replacement of the adsorber catalyst bed or the trap filter after as little as 100,000–150,000 miles if there was a ''reasonable likelihood'' that the maintenance would get done. We are concerned that some manufacturers may underdesign the adsorbers and traps compared to the level of durability that is achievable. If this occurred, even if most users replaced their adsorber or trap according to the manufacturer's schedule, there would certainly be some users that did not. Therefore, we are proposing to require that these technologies be designed to last for the full useful life of the engine. More specifically, the proposed regulations state that scheduled replacement of the PM filter element or catalyst bed is not allowed during the useful life. Only cleaning and adjustment will be allowed as scheduled maintenance.

It may be appropriate to establish non-conformance penalties (NCPs) for the standards being proposed today. NCPs are monetary penalties that manufacturers can pay instead of complying with an emission standard. In order for us to establish NCPs for a specific standard, we would have to find that: (1) Substantial work will be required to meet the standard for which the NCP is offered; and (2) there is likely to be a ''technological laggard'' (*i.e.*, a manufacturer that cannot meet the standard because of technological (not economic) difficulties and, without NCPs, might be forced from the marketplace). According to the CAA (section 206(g)), such NCPs ''shall remove any competitive disadvantage to manufacturers whose engines or vehicles achieve the required degree of emission reduction.'' We also must determine compliance costs so that appropriate penalties can be established. We have established NCPs in past rulemakings. However, since the implementation of our averaging, banking and trading program, their use has been rare. We believe manufacturers have taken advantage of the averaging, banking and trading program as a preferred alternative to incurring monetary losses. At this time, we have insufficient information to evaluate these criteria for heavy-duty engines. While we believe that substantial work will be required to meet the 2007 standards, we currently have no information indicating that a technological laggard is likely to exist. Recognizing that it may be premature for manufacturers to comment on these criteria, since implementation of these standards is still more than six years away, we expect to consider NCPs in a future action. We welcome comment on this approach.

Today's proposal includes PM standards for heavy-duty gasoline engines. Because gasoline engines have inherently low PM emissions, it may be appropriate in some cases to waive the requirement to measure PM emissions. Therefore, we are proposing to maintain the flexibility to allow manufacturers to certify gasoline engines without measuring PM emissions, provided they have previous data, analyses, or other information demonstrating that they comply with the standards. The flexibility is the same as that allowed for PM emissions from light-duty gasoline vehicles and for CO emissions from heavy-duty diesel engines.

B. Certification Fuel

It is well established that measured emissions are affected by the properties of the fuel used during the test. For this reason, we have historically specified allowable ranges for test fuel properties such as cetane and sulfur content. These specifications are intended to represent most typical fuels that are commercially available in use. Because today's action is proposing to lower the upper limit for sulfur content in the field, we are also proposing a new range of allowable sulfur content for testing that would be 7 to 15 ppm (by weight). Beginning in the 2007 model year, these specifications would apply to all emission testing conducted for Certification and Selective Enforcement Audits, as well as any other laboratory engine testing for compliance purposes. Because the same in use fuel is used for light-and heavy-duty highway diesel vehicles, we are also proposing to change the sulfur specification for light-duty diesel vehicle testing to the same 7 to 15 ppm range, beginning in the 2007 model year. We request comment on these test fuel specifications. We also request comment regarding whether the range of allowable test fuel properties should include the full range of in-use properties or include the most typical range around the average properties (*e.g.*, 7 to 10 ppm sulfur).

C. Averaging, Banking, and Trading

We are proposing to continue the basic structure of the existing ABT program for heavy-duty diesel engines. (Note that this includes the Otto-cycle engine and vehicle ABT programs that were proposed on October 29, 1999, 64 FR 58472.) This program allows manufacturers to certify that their engine families comply with the applicable standards on average. More specifically, manufacturers are allowed to certify their engine families with various family emission limits (FELs), provided the average of the FELs does not exceed the standard when weighted by the numbers of engines produced in each family for that model year. To do this, they generate certification emission credits by producing engine families that are below the applicable standard. These credits can then be used to offset the production of engines in engine families that are certified to have emissions in excess of the applicable standards. Manufacturers are also allowed to bank these credits for later use or trade them to other manufacturers. We are proposing some restrictions to prevent manufacturers from producing very high-emitting engines and unnecessarily delaying the transition to the new exhaust emission control technology. These restrictions are described below. We are continuing this ABT program because we believe that it would provide the manufacturers significant compliance flexibility. This compliance flexibility would be a significant factor in the manufacturers' ability to certify a full line of engines in 2007 and would help to allow implementation of the new, more stringent standard as soon as permissible under the CAA. This is especially true given the very low levels of the proposed standards. In some ways the ABT program is intended to serve the same purpose as the phase-in for diesel engines. As is described below, we have proposed some restrictions to make this program compatible with the phase-in. Thus your comments on this ABT program should address how it fits with the phase-in, and vice versa.

The existing ABT program includes limits on how high the emissions from credit-using engines can be. These limits are referred to as FEL caps. No engine family may be certified above these caps using credits. These limits provide the manufacturers compliance flexibility while protecting against the introduction of unnecessarily high-emitting engines. In today's action, we are proposing to establish lower caps for those engines that are required to comply with the proposed standards. Specifically, we are proposing that the engines subject to the new standards have NO_X emissions no higher than 0.50 g/bhp-hr, and PM emissions no higher than 0.02 g/bhp-hr. Without this cap, we are concerned that one or more manufacturer(s) could use the ABT program to unnecessarily delay the introduction of exhaust emission control technologies. Allowing this would be contrary to one of the goals of the phase-in program, which is to allow manufacturers to gain experience with these technologies on a limited scale before they are applied to their full production. Similarly, we are proposing FEL caps of 1.0 g/mi NO_X and 0.03 g/mi PM for chassis-certified heavy-duty vehicles. We request comment on the need for and the levels of these FEL caps.

We are proposing separate averaging sets during the phase-in period. In one set, engines would be certified to the 2.4 g/bhp-hr NO_X+NMHC standard (which applies for model years 2004–2006), and would be subject to the restrictions and allowances established for those model years. In the other set, engines would be certified to the proposed 0.20 g/bhp-hr NO_X standard, and would be subject to the restrictions and allowances proposed today. Averaging would not be allowed between these two sets within the same model year. The reason for this is similar to that for the low FEL caps. Allowing averaging between the sets would be contrary to one of the goals of the phase-in program, which is to allow manufacturers to introduce engines with ultra-low emission technologies on a limited scale before they are applied to their full production. We are concerned that manufacturers could delay the introduction of NO_X aftertreatment technology, diminishing the projected benefits of the proposed program during the phase-in. We request comment on the need for this restriction. As a part of this restriction of cross-set averaging, we are also proposing that banked NO_X+NMHC and PM credits generated from 2006 and earlier engines may not be used to comply with the stricter standards that apply to 2007 and later engines (unless such credits are generated from engines that meet all of the stricter standards early). We are also requesting comments on alternatives to these restrictions, such as only allowing banked credits generated from engines below some threshold (*e.g.,* 1.5 g/bhp-hr NO_X+NMHC or 0.05 g/bhp-hr PM) to be used for compliance with the 2007 standards. Under the threshold approach, the credits would be calculated in reference to the threshold rather than the applicable standard. Your alternatives should address our two primary concerns: (1) Ensuring that manufacturers produce engines during the phase-in period that are equipped with the advanced NO_X aftertreatment controls; and (2) ensuring that the program produces equivalent or greater emission reductions during the phase-in period.

We propose to apply these same restrictions to the 2007 chassis-based standards. This would affect the averaging program that was proposed previously for model year 2004 (October 29, 1999, 64 FR 58472). We believe that these restrictions are equally necessary for the chassis-based program, but are also open to alternatives. We are particularly interested in the possibility of using the Tier 2 pull-ahead approach that would allow manufacturers to phase in the new standards on a per-vehicle basis rather than on a total gram basis. Under this approach, for each ''2007-technology'' vehicle that a manufacturer introduced before 2007, it could produce one ''2006-technology'' vehicle in 2007 or later. We recognize that this approach would be complicated for heavy-duty vehicles because of the different weight classes, but believe that this problem could be addressed with appropriate weighting factors (*e.g,* setting one 14,000 lb vehicle as equivalent to two 8,500 lb vehicles). While it is less clear that such an approach would work for the engine programs, we would welcome such comments.

The Agency continues to be interested in the potential of early benefits to be gained from retrofitting highway engines. Thus, we are also asking for comment on various concepts by which manufacturers could earn credits potentially to be used in a variety of programs. An example of such credits in the 2007 MY program might include consideration by EPA of the retiring of retrofit credits in deciding whether to make a discretionary determination under section 207(c) of substantial non-conformity. For discussion of related issues, see the final rule for spark-ignition marine engines (61 FR 52088, 52095, October 4, 1996), and the final rule for locomotive engines (63 FR 18978, 18988, April 16, 1998). We ask for comment as to what emission benefits could be achieved by this concept and by what legal authority such credits could be applied. Such systems would bring existing highway engines into compliance with the standards being proposed for new engines, or alternately with some less stringent standards levels that still achieve large emission reductions. We ask comment on how such an emissions reduction calculation should be formulated and how such benefits and resulting credits should be applied. Certification requirements for such retrofit systems could be developed along the lines of those adopted in EPA's urban bus retrofit program (58 FR 21359, April 21, 1993). Credits would be calculated based on the expected lifetime emissions benefits of the retrofit systems. Because this benefit depends on the remaining life of the retrofitted vehicle, and this could vary considerably, any emission reduction formula would require the certainty to account for this in the calculation, such as by estimating an average remaining life for retrofits in each engine family, or by using a vehicle age-dependent proration factor for each retrofitted system, similar to the approach taken in the locomotive emissions rule (see Appendix K of the Regulatory Support Document for the locomotives final rule. 63 FR 18977, April 16, 1998).

D. Chassis Certification

Heavy-duty vehicles under 14,000 pounds can generally be split into two groupings, complete and incomplete vehicles. Complete vehicles are those that are manufactured with their cargo carrying container attached. These vehicles consist almost entirely of pick-up trucks, vans, and sport utility vehicles. Incomplete vehicles are those chassis that are manufactured by the primary vehicle manufacturer without their cargo carrying container attached. These chassis may or may not have a cab attached. The incomplete chassis are then manufactured into a variety of vehicles such as recreational vehicles, tow trucks, dump trucks, and delivery vehicles.

Recently, we proposed to require all complete Otto-cycle vehicles between 8,500 and 14,000 pounds to be certified to vehicle-based standards rather than engine-based standards beginning in model year 2004 (October 29, 1999, 64 FR 58472). Under this proposal manufacturers would test the vehicles in essentially the same manner light-duty trucks are tested. We continue to believe this approach is reasonable and are thus proposing to continue it with the more stringent standards. We request comment regarding the possible mandatory or voluntary application of this program to complete diesel vehicles under 14,000 pounds.

E. FTP Changes to Accommodate Regeneration of Aftertreatment Devices

It is possible that some of the exhaust emission control devices used to meet the proposed standard will have discrete regeneration events that could effect emission characteristics. For example, NO_X adsorbers and actively regenerated PM traps each incorporate discrete regenerations. The NO_X adsorber stores NO_X under normal conditions until the NO_X storage capacity is nearly full, at which point, the regeneration event is triggered to purge the stored NO_X and reduce it across a catalyst. Actively regenerated PM traps incorporate heating devices to periodically initiate regeneration. In both cases, we would expect that these regeneration events would be controlled by the engine computer, and would thus be generally predictable. Even passively regenerating catalytic PM trap designs can have discrete regeneration events.

Discrete regeneration events can be important because it is possible for exhaust emissions to increase during the regeneration process. The regeneration of a NO_X adsorber for instance, could result in increased particulates, NMHC and NO_X due to the rich exhaust gas required to purge and reduce the NO_X. We expect that in most cases, the regeneration events would be sufficiently frequent to be included in the measured emissions. Our feasibility analysis projects very frequent regeneration of the NO_X adsorbers, and continuously regenerating PM traps. Nevertheless, this issue becomes a regulatory concern because it is also conceivable that these emission storage devices could be designed in such a way that a regeneration event would not necessarily occur over the course of a single heavy-duty FTP cycle, and thus be unmeasured by the current test procedure. Since these regeneration events could produce increased emissions during the regeneration process, it will be important to make sure that regeneration is captured as part of the certification testing. We seek comment on the need to measure regeneration emissions as part of each emission test, and the best method of making such measurements.

In order to verify the emission levels during regeneration, we propose that the transient FTP applicable for certification be repeated until a regeneration occurs. The transient FTP will be repeated until a regeneration event is confirmed. The emissions measured during the cycle in which the regeneration occurs must be below the applicable transient cycle standard. For example, if an actively regenerated heavy-duty PM trap does not regenerate over the cold-soak-hot cycle, the hot portion of the cycle will be repeated until a regeneration is observed. The specific hot cycle with the highest emissions would be used as the representative hot cycle, and its emissions would be weighted with the cold cycle emissions (as is currently required) to determine compliance with the composite emission standard for the cold-soak-hot cycle. We seek comment on the proposed method of capturing regeneration emissions and whether we should allow the manufacturers to use the average hot-start emissions rather than the worst case.

This proposal is based on the assumption that the systems would include a fairly high frequency of regeneration events (*e.g.,* one regeneration event per hour). We seek comment on the need to capture regeneration emissions as part of the certification testing if the regeneration events occur much less frequently. Similarly, we request comment on the need to measure emissions during desulfurization of the NO_X adsorber. Would it be appropriate to allow manufacturers to use a mathematical adjustment of measured emissions to account for increased emissions during infrequent regeneration or desulfurization events? For example, if a system required a desulfurization after every 20 transient cycles, and PM emissions increased by 20 percent during desulfurization, would it be appropriate to adjust measured emissions upward by one percent (20 percent divided by 20 cycles)?

F. On-Board Diagnostics

OBD systems help ensure continued compliance with emission standards during in-use operation, and they help mechanics to properly diagnose and repair malfunctioning vehicles while minimizing the associated time and effort. We implemented OBD requirements on light-duty applications in the 1994 model year (58 FR 9468, February 19, 1993). We recently proposed OBD requirements for 8500 to 14,000 pound heavy-duty gasoline and diesel applications (October 29, 1999, 64 FR 58472). The 8500 to 14,000 pound requirements are scheduled for implementation in the 2004 model year with a phase-in running through the 2006 model year; the 2007 model year would be the first year of 100 percent OBD compliance on 8500 to 14,000 pound applications. We are currently working with industry to develop OBD requirements for the over 14,000 pound heavy-duty gasoline and diesel engines. Those requirements will be proposed in a separate rulemaking and are anticipated to be effective on or before the 2007 model year; consequently, we are not proposing them here.

As discussed in the October 29, 1999, proposed rule, OBD system requirements would allow for potential inclusion of heavy-duty vehicles and engines in inspection/maintenance programs via a simple check of the OBD system. The OBD system must monitor emission control components for any malfunction or deterioration that could cause exceedance of certain emission thresholds. The OBD system also notifies the driver when repairs are needed via a dashboard light, or malfunction indicator light (MIL), when the diagnostic system detects a problem.

An OBD system is important on heavy-duty vehicles and engines for many reasons. In the past, heavy-duty diesel engines have relied primarily on in-cylinder modifications to meet emission standards. For example, emission standards have been met through changes in injection timing, piston design, combustion chamber design, use of four valves per cylinder rather than two valves, and piston ring pack design and location improvements. In contrast, the proposed 2004 and 2007 standards represent a significant technological challenge that would require use of EGR and exhaust emission control devices whose deterioration or malfunction can easily go unnoticed by the driver. The same argument is true for heavy-duty gasoline vehicles and engines; while emission control is managed both with engine design elements and exhaust emission control devices, the latter are the primary emission control features. Because deterioration and malfunction of these devices can go unnoticed by the driver, and because their sole purpose is emissions control, some form of detection is crucial. An OBD system is well suited to detect such deterioration or malfunction.

Today's proposal does not contain any new OBD requirements. The vehicles and engines designed to comply with today's proposed emission standards would be required to comply with the OBD requirements already in place or proposed for implementation in the 2004 model year (*i.e.,* light-duty and heavy-duty through 14,000 pounds). However, because some of the existing OBD requirements are based on multipliers of the applicable emission standards, we request comment regarding the effect of the low levels of the proposed standards on these OBD requirements. We believe that these requirements will be feasible for these engines. If you believe that the OBD requirements will not be feasible, you should include in your comments suggestions for how they should be revised to make them feasible.

We are also requesting comment regarding whether there are new OBD requirements that should be adopted for these exhaust emission control technologies. Comments supporting new requirements should indicate whether they would be intended only to prevent emission problems, or would also be intended to prevent performance problems, such as exhaust emission control plugging.

G. Supplemental Test Procedures

To ensure better control of in-use emissions, we recently proposed (October 29, 1999, 64 FR 58472) [166] to add two supplemental sets of requirements for heavy-duty diesel engines: (1) A supplemental steady-state test and accompanying limits; and (2) NTE Limits. Both types of these proposed supplemental emission requirements are expressed as multiples of the normal duty cycle-weighted emission standards, or FEL if the engine is certified under the ABT program, whichever is applicable. For example, the diesel engine NTE limit for NO_X + NMHC emissions from 2004 engines would be 1.25 times the 2.4 g/bhp-hr emission standard, or 1.25 times the applicable FEL. Although we are not proposing any changes to these requirements, we are requesting comment on the feasibility of technologies needed to meet the standards being proposed in this notice, in the context of applying these multipliers to these new standards.

Like current requirements, these new requirements would apply to certification, production line testing, and vehicles in actual use. All existing provisions regarding standards (*e.g.,* warranty, certification, recall) would be applicable to these new requirements as well. The steady-state test was proposed because it represents a significant portion of in-use operation of heavy-duty diesel engines that is not adequately represented by the FTP. The combination of these supplemental requirements is intended to provide assurance that engine emissions achieve the expected level of in-use emissions control over expected operating regimes in-use. We stated in the previous NPRM that we believed that compliance with these requirements would not require manufacturers to add additional emission control technologies, but would require manufacturers to put forth some effort to better optimize their engines with respect to emissions over a broader range of operating conditions. You should read the previous NPRM for more detail. You should also read the comments that we received in response to this proposal. In those comments, some engine manufacturers raised concerns regarding the feasibility of implementing these requirements in the 2004 model year, in the context of the technologies expected to be seen in the 2004 time frame (principally cooled EGR, advanced fuel injection systems, advanced turbo-charging systems).[167] Many of these comments question the feasibility of meeting the proposed NTE emission limits under the high-load regions of the proposed NTE zone, particularly under conditions of high temperature and/or altitude. These comments are highlighted here because the resolution of these issues for the 2004 diesel engine standards, may also be relevant to today's rulemaking.

We plan to apply these requirements with the proposed 2007 standards in the same manner as they would be applied with the 2004 standards, if adopted. There is some concern that certain exhaust emission control devices, though capable of providing large emission reductions and performing robustly over a wide range of expected operating conditions, may have degraded performance in some conditions included in the NTE or supplemental steady-state testing requirements. We are thus asking for comments and supporting data related to this concern. Your comments should address the following questions:

—What is the relative ability of the emission control technologies being considered in today's action to control emissions over the full range of speeds and loads typically encountered in actual use? Are there areas of the map in which the emission controls are significantly less effective?
—What is the relative need for emission reduction for different areas of the speed-load map?
—How do the emission control technologies being considered in today's action perform at different ambient conditions?
—Are the multipliers proposed previously the most appropriate multipliers for ensuring in-use emissions control on exhaust emission control-equipped engines?
—Are there other cost effective approaches to controlling in-use emissions for engines equipped with exhaust emission controls?
—Are the technological issues raised in the 2004 rulemaking equally applicable to diesel engines featuring

[166] Today's notice proposes to apply the heavy-duty diesel NTE and supplemental steady-state test provisions intended to be finalized as part of the 2004 standards rulemaking. The October 29, 1999 proposal for that rule contained the description of these provisions. We expect that a number of modifications will be made to those provisions in the FRM for that rule based on feedback received during the comment period. While the details of the final provisions are not yet available, we will provide the necessary information in the docket for this rule as soon as it becomes available in order to allow for comment.

[167] See, for example, comments from Engine Manufacturers Association, Detroit Diesel Corporation, Navistar International Transportation Corp., Mack Trucks Inc., in EPA Air Docket No. A–98–32.

advanced exhaust emission controls and designed to meet the proposed 2007 standards?

H. Misfueling Concerns

As explained in Section III, the emissions standards contained in this proposal will likely make it necessary for manufacturers to employ exhaust emission control devices that require low-sulfur fuel to ensure proper operation. This proposal therefore restricts the sulfur content of highway diesel fuel sold in the U.S. There are, however, some situations in which vehicles requiring low-sulfur fuel may be accidentally or purposely misfueled with higher-sulfur fuel. Vehicles operated within the continental U.S. may cross into Canada and Mexico, countries which have not confirmed that they plan to adopt the same low sulfur requirements we are proposing here. In addition, high-sulfur nonroad fuel may illegally be used by some operators to fuel highway vehicles. Any of these misfueling events could seriously degrade the emission performance of sulfur-sensitive exhaust emission control devices, or perhaps destroy their functionality altogether.

There are, however, some factors that help to mitigate concerns about misfueling. Most operators are very conscious of the need to ensure proper fueling and maintenance of their vehicles. The fear of large repair and downtime costs may often outweigh the temptation to save money through misfueling.

The likelihood of misfueling in Canada and Mexico is lessened by current cross-border shipment practices and prospects for eventual harmonization of standards. Canada has historically placed a priority on harmonization with U.S. vehicle emission standards. They have also placed a priority on harmonization with U.S. fuels standards, as they import a significant amount of fuel from the U.S. and do not want to become a ''dumping ground'' for fuel that does not comply with U.S. fuel standards. We think it likely therefore that Canada will harmonize with the U.S. revised engine standards and the fuel sulfur levels required to support those standards. This will offer vehicle owners the option of refueling with low-sulfur fuel there. Even if Canada were to lag the U.S. in mandating low-sulfur fuels, these fuels would likely become available along major through routes to serve the needs of U.S. commercial traffic that have the need to purchase it. In addition, there is less potential for U.S. commercial vehicles needing low-sulfur fuel to refuel in Canada because Canadian fuel is currently more costly than U.S. fuel. As a result, most vehicles owners will prefer to purchase fuel in the U.S., prior to entering Canada, whenever possible. This is facilitated by large tractor-trailer trucks that can have long driving ranges—up to 2,000 miles or so—and the fact that most of the Canadian population lives within 100 miles of the United States/Canada border.

In Mexico, the entrance of trucks beyond the border commercial zone has been prohibited since before the conclusion of the North American Free Trade Agreement in 1994. This prohibition applies in the U.S. as well, as entrance of trucks into the U.S. beyond the border commerce zone is also not allowed. Since these prohibitions are contrary to the intent of the Free Trade Agreement, a timetable was established to eliminate them.[168] However, these prohibitions are a point of contention between the U.S. and Mexico and remain in force at this time.

The NAFTA negotiations included creation of a ''corridor'' where commercial truck travel occurs, and where Mexico is obligated to provide ''low-sulfur'' fuel. At the time of the NAFTA negotiations, ''low-sulfur'' fuel was considered 500 ppm, which was the level needed to address the needs of engines meeting the 1994 emission standards. The travel prohibition currently in place may be lifted at some point. At that time, the issue of assuring, for U.S. vehicles, fuel with a sulfur level needed by the technology that results from this regulation may need to be addressed.

Even considering these mitigating factors, we believe it is reasonable to propose two additional measures with very minor costs to manufacturers and consumers. First, we are proposing a requirement that heavy-duty vehicle manufacturers notify each purchaser of a model year 2007 or later diesel-fueled vehicle that the vehicle must be fueled only with the low-sulfur diesel fuel meeting our regulations. We believe this requirement is necessary to alert vehicle owners to the need to seek out low-sulfur fuel when operating in areas such as Canada and Mexico where it may not be widely available. We are also proposing that model year 2007 and later heavy-duty diesel vehicles must be equipped by the manufacturer with labels on the dashboard and near the refueling inlet that say: ''Ultra-Low Sulfur Diesel Fuel Only.'' We request comment on the need for these measures, alternative suggestions for wording, whether or not these requirements should exist for only a limited number of years, and whether any vehicles certified to the new standards without the need for low-sulfur fuel should be exempted. We also request comment on whether additional measures are needed to preclude misfueling, such as requiring that the new technology vehicles be equipped with refueling inlet restrictors that can only accept refueling nozzles from pumps that dispense low-sulfur fuel. We would also need to require that these pumps (or the high-sulfur fuel pumps) be correspondingly equipped with specialized nozzles or other devices to complement the vehicle refueling inlet restrictor.

I. Light-Duty Provisions

We are proposing that the heavy-duty vehicle labeling and purchaser notification requirements discussed in section VII.H be applied to the light-duty diesel vehicles certified to the final Tier 2 standards as well, because these vehicles are expected to require the low-sulfur fuel and so would be equally susceptible to misfueling damage.

J. Correction of NO_X Emissions for Humidity Effects

Engine-out emissions of NO_X are known to be affected significantly by the amount of moisture in the intake air. The water absorbs heat which lowers combustion temperatures, and thus lowers NO_X emissions. Our existing regulations include equations that give correction factors to eliminate this effect. For example, if the equation indicated that NO_X emissions measured on a relatively high humidity day would be about three percent lower than would be expected with standard humidity, they would be multiplied by 1.03 to correct them to standard conditions. However, these equations were developed many years ago, based on data from older technology engines. We are concerned that these equations may not be valid for engines equipped with catalytic emission controls. It is possible that with catalytic systems, the effect may be very different. Perhaps with these newer technologies, the effect will not be significant and correction factors will not be needed. Therefore, we are requesting comment regarding the accuracy of the existing equations for engines equipped with NO_X adsorbers, and the need for such correction factors for the 2007 standards. To the extent possible, your comments should address the broader issue of the need for correction factors for NO_X and other

[168] See NAFTA, Volume II, Annex I, Reservations for Existing Measures and Liberalization Commitments, Pages I–M–69 and 70, and Pages I–U–19 and 20.